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Indian Journal of
POWER & RIVER VALLEY DEVELOPMENT

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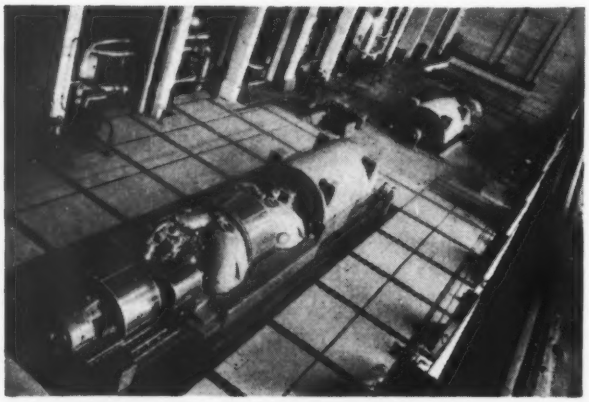

▲ ALSTHOM – Carling Power Station, France. 110,000 KW turboset. 14,500 volts, 3,000 RpM, steam pressure 1250 psig at 968°F.

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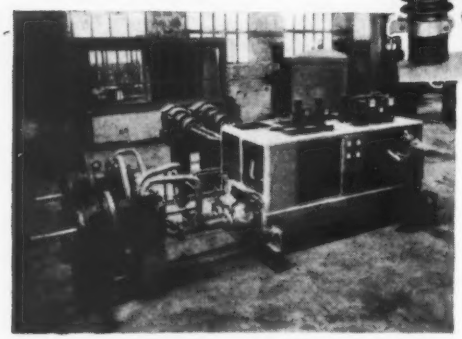
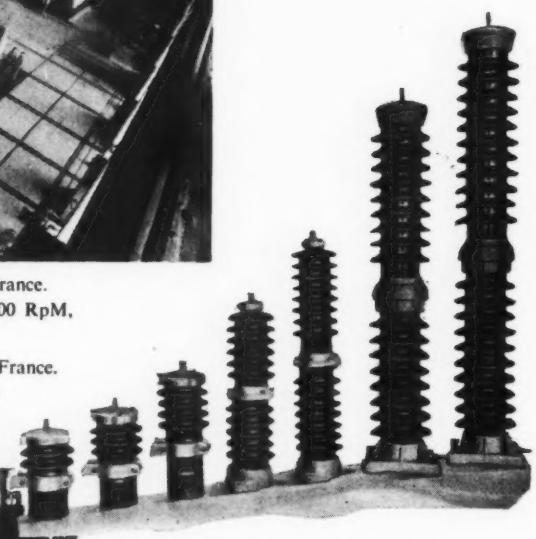


C. G. E. – Lightning arresters, type PFT. Discharge capacity, 1500 amps, 7 to 60 KV. ▼



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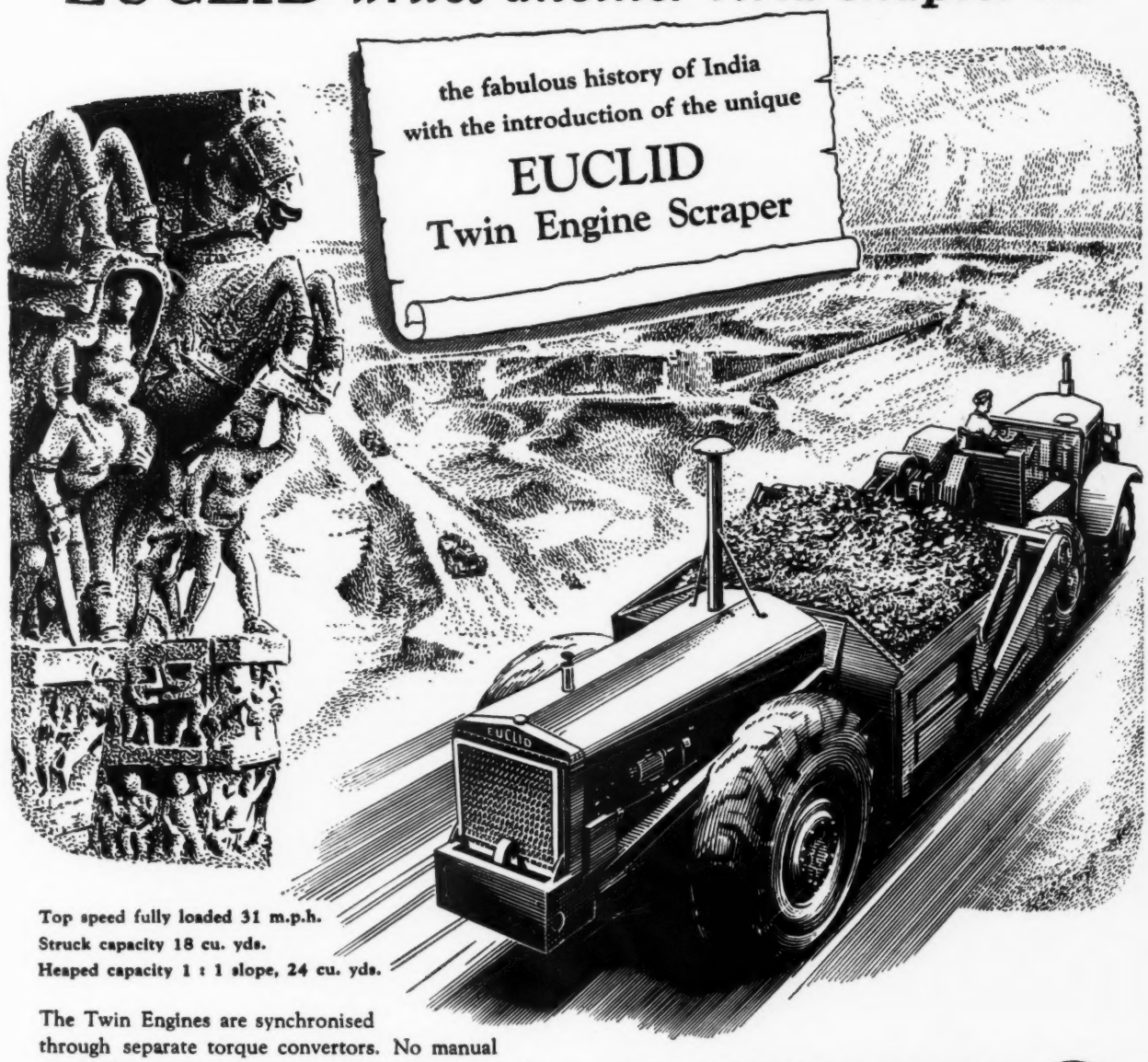

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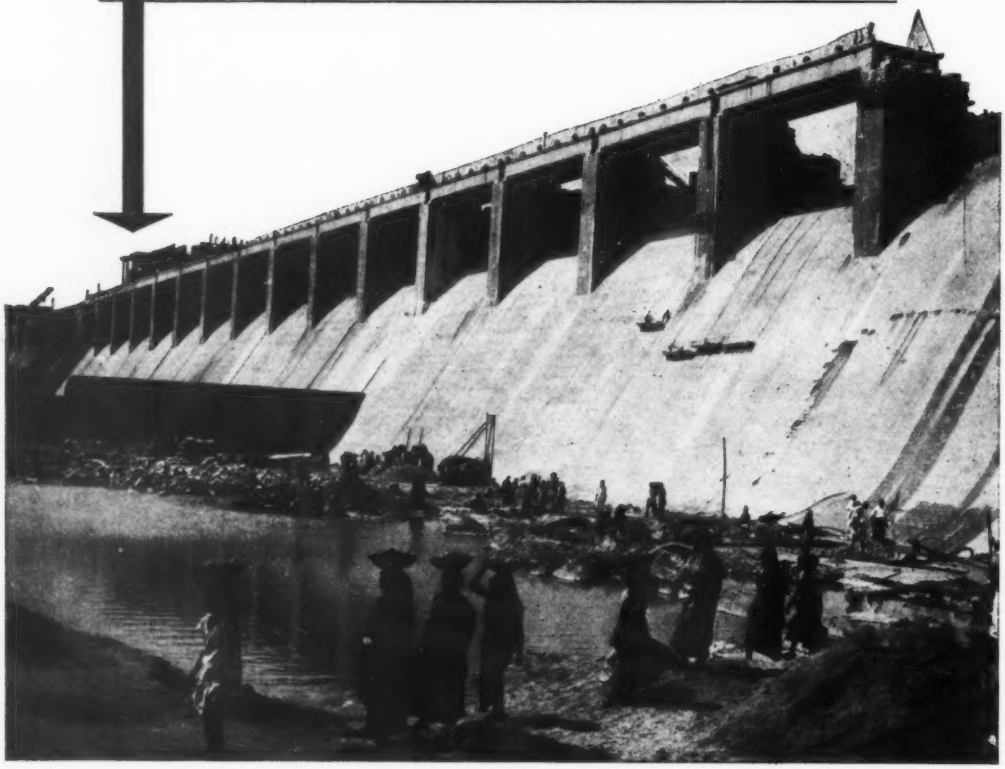

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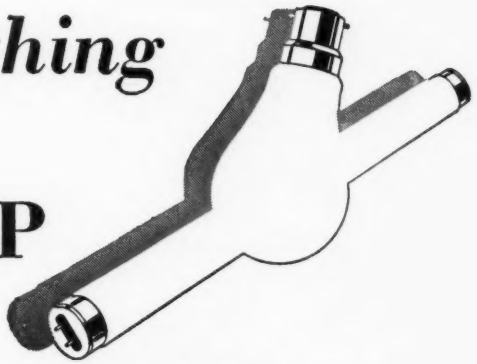

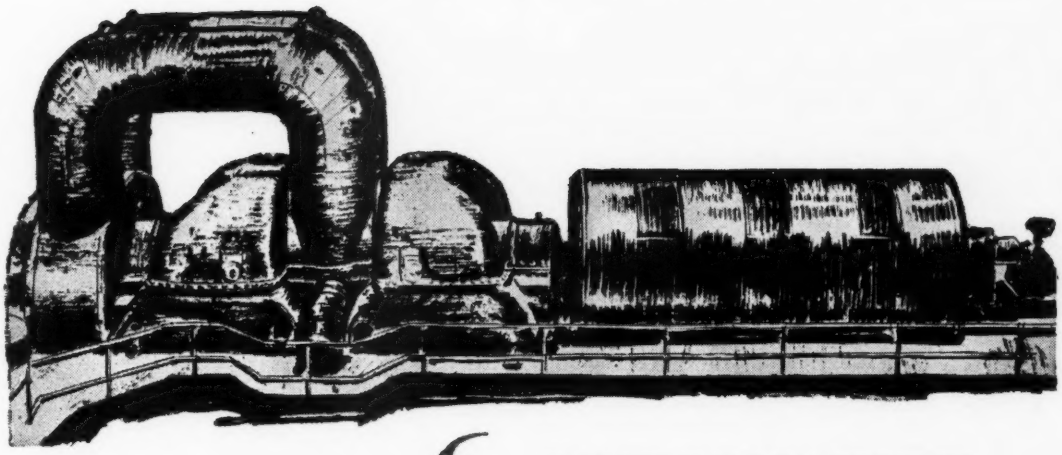

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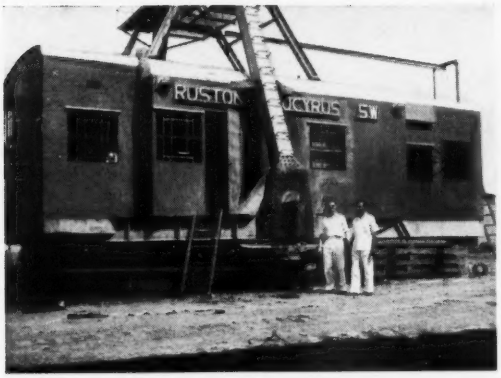
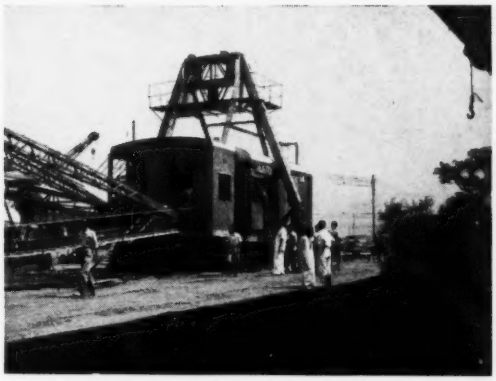
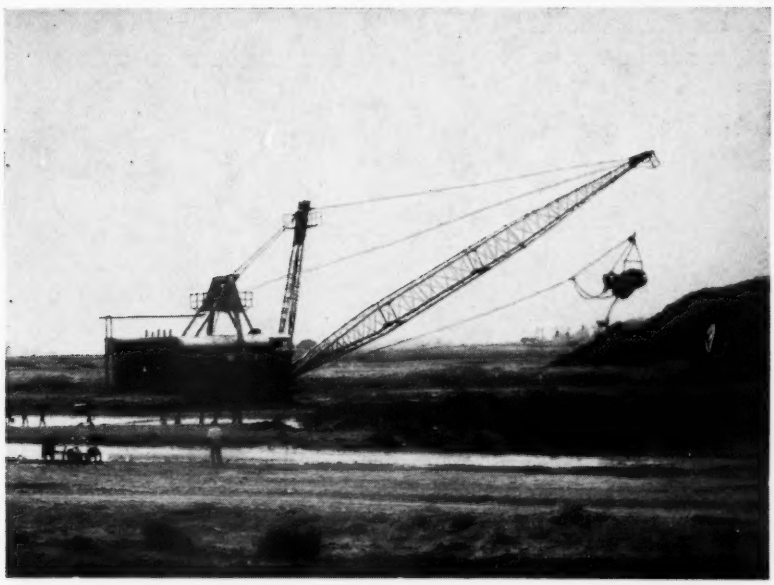
RUSTON — BUCYRUS

machines at work on India's POWER & RIVER VALLEY DEVELOPMENT





Ruston-Bucyrus 5 W Walking Dragline being erected at Durgapur.
One of the 350 BUCYRUS machines now working in India.



At work on a D. V. C. canal, at Durgapur.

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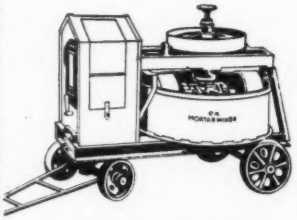

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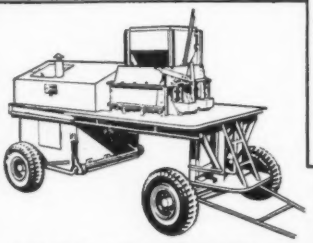

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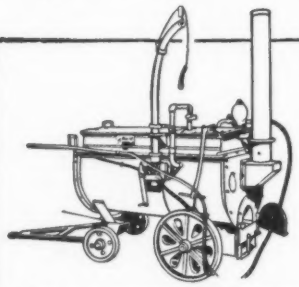

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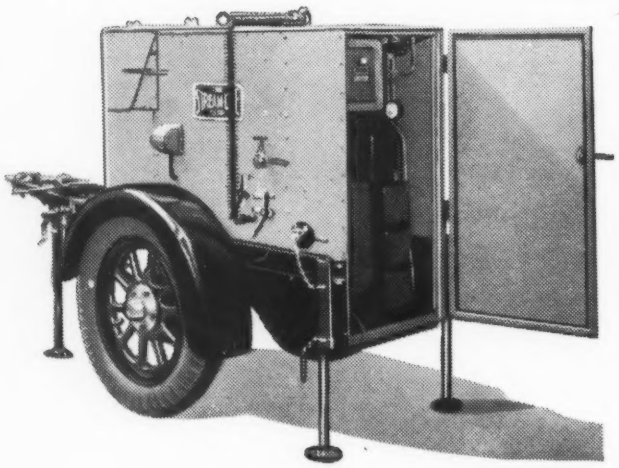

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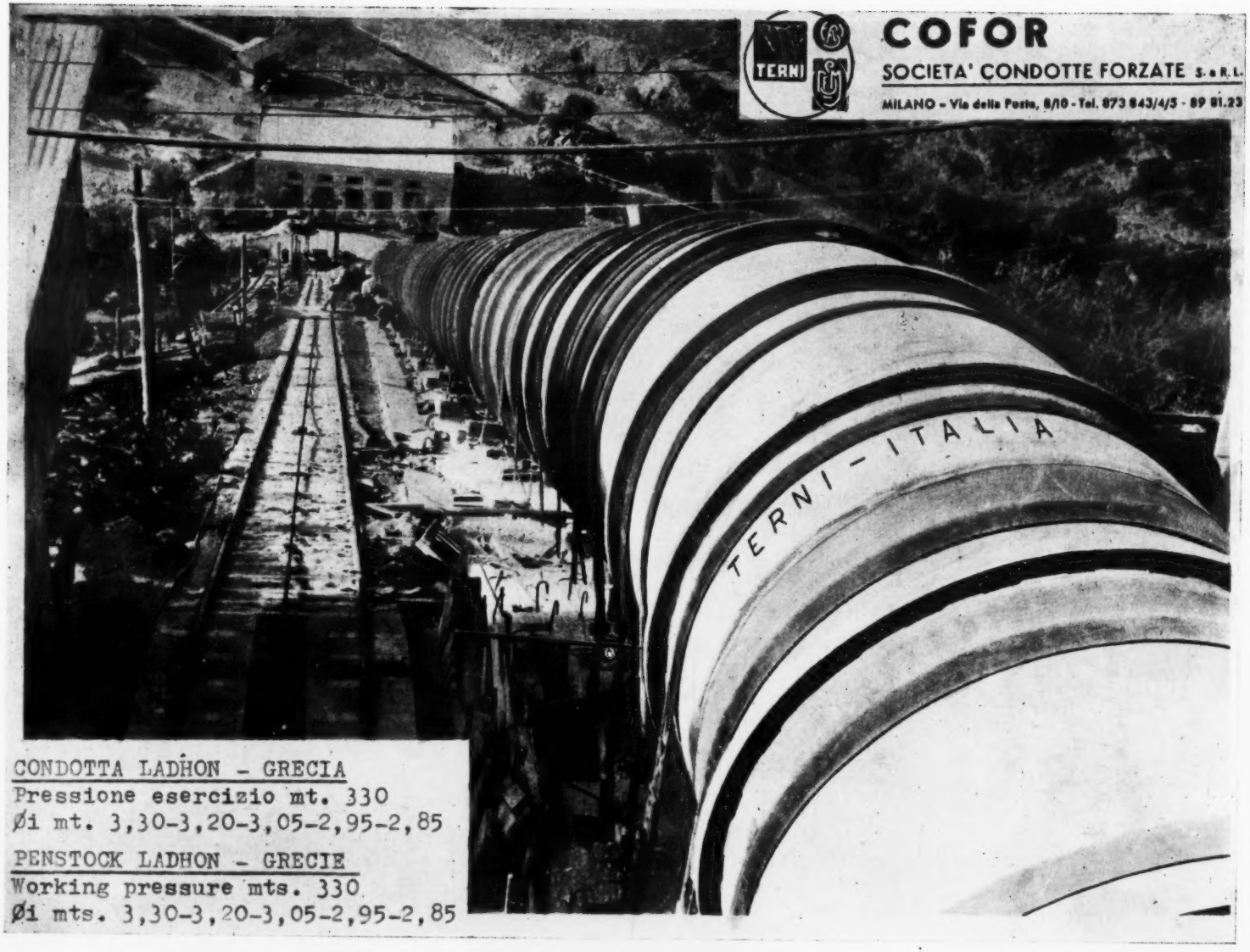

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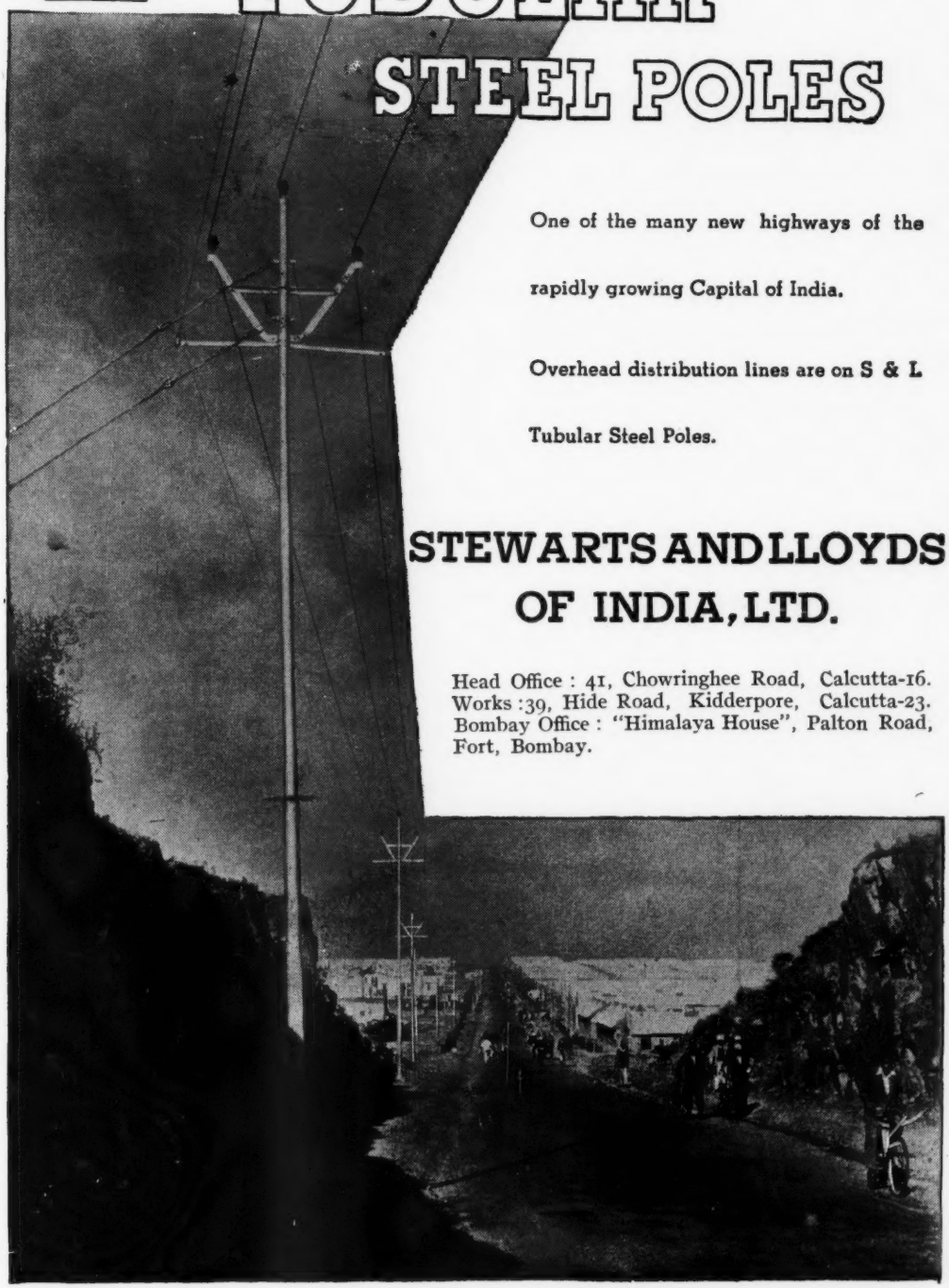

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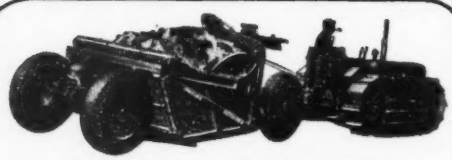

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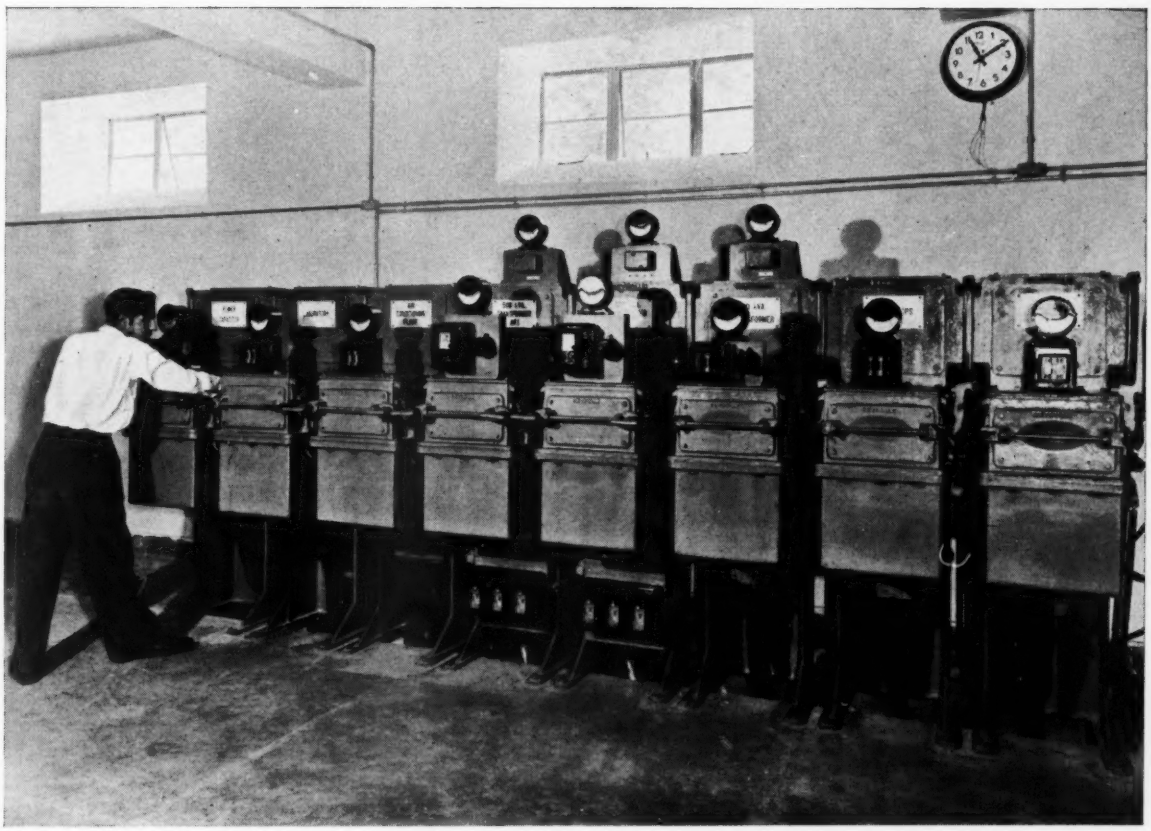

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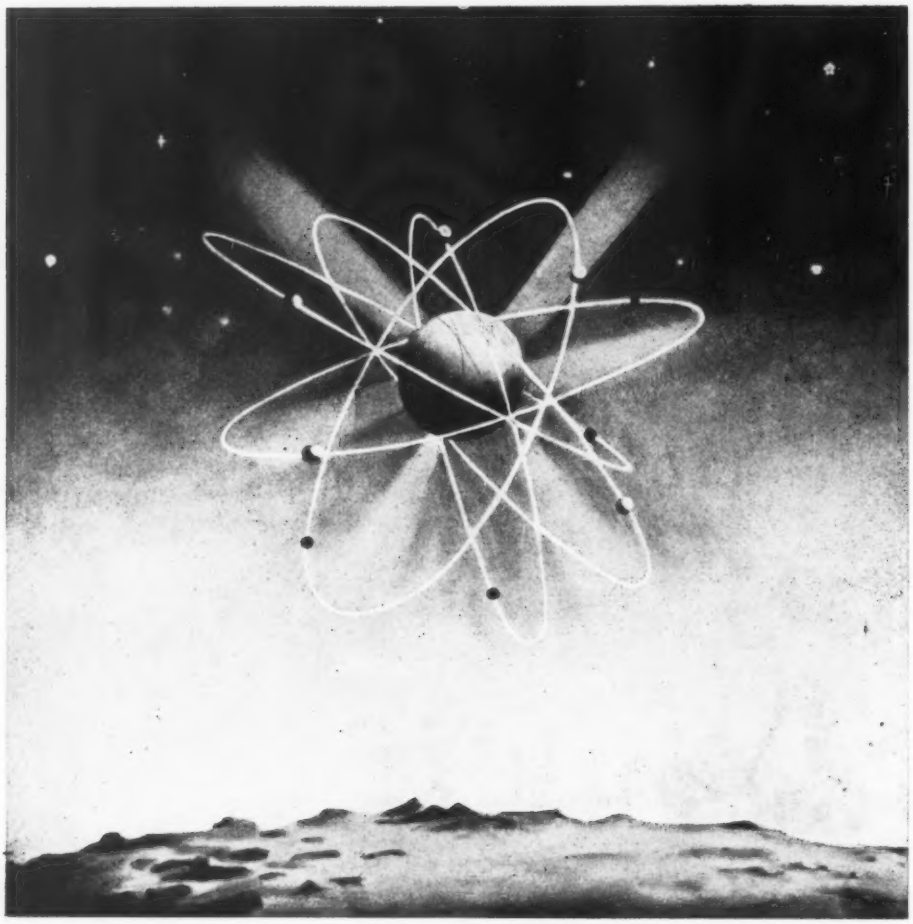

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A MONTHLY DEVOTED TO DEVELOPMENT OF POWER & WATER RESOURCES IN ASIA

Editor : **K. K. Sinha** **P. K. Menon** : Mg. Editor

Vol. V April 1955 No. 4

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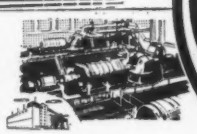
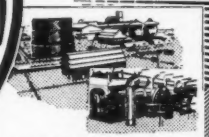


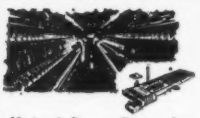
Bokaro Thermal Station.



Sindri Fertilizer Factory.

INSTALLATIONS FOR INDIA'S DEVELOPMENT

The Tata Iron & Steel Co., Jamshedpur.



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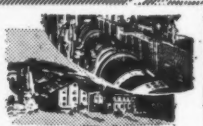
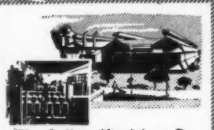


Andhra Valley Power Station, Bombay.

Progress Is Our Most Important Product



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Nuclear Energy Plants

LEO WALTER

Even since 1945 great interest has been attached to the idea of generating electric power for industrial use from the release of nuclear energy. Although greater part of the effort has been devoted to production of more efficient weapons of destruction, the constructive uses of atomic energy has not been entirely neglected. The production of electricity from it has, as a result of these painstaking and persevering efforts, now become a reality. Welcome news comes from the U.K., Russia, Canada, United States and other countries. Although much of the information is shrouded still in mystery and secrecy, it will be interesting to follow the following special contribution with keen interest.

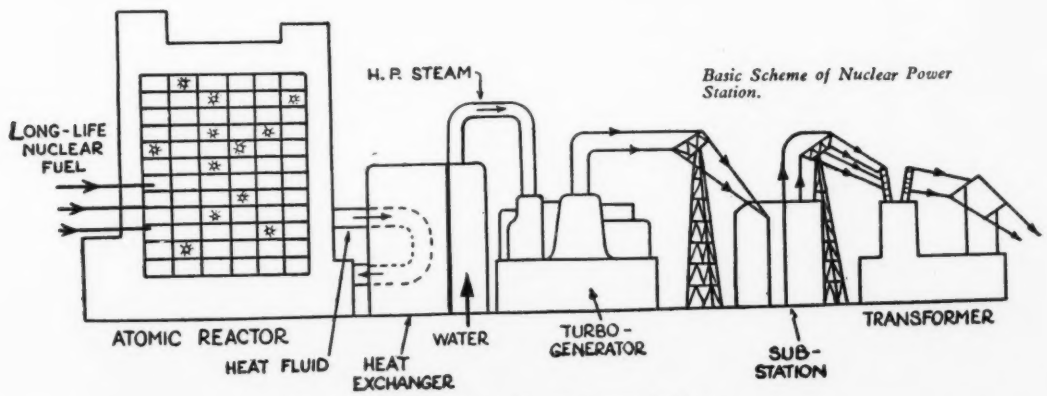
AUTHOR

A good deal of research on practical use of nuclear energy for producing electric power is being done in all leading industrial countries, including Canada, but the real amount of progress being made is not easy to assess for the electrical power engineer. The reason is, of course, that in most industrial countries production and use of nuclear products until recently has been entirely in the hands of Government Departments, and the engineering world depends more or less on bits of information disseminated in the form of "declassified" items. As regards erection of atomic power stations the following emanates. Soviet Russia is said to be at work building new industrial power stations of 50,000 and 100,000 kW capacity following the recent opening of a 5,000 kW atomic power plant. In the U.S.A. a start has been made on erection of a nuclear power plant near Pittsburgh, Pa. The exact location of this first American Nuclear Power Plant is Shippingport, and it will have a capacity of 60 MW. It has been disclosed that pressure within the reactor shell will be in the region of 2000 *psi* (140 atmosph), necessitating a pressure enclosure made from steel. The reactor core will be placed underground, and the same applies to the pressure heat exchangers. Steam turbines of conventional modern design will be used. The whole plant will consist of a chemical section for producing the nuclear fuel, the underground buildings for reactor and heat exchangers, a building for fans etc., the turbine house, and the station for distribution of electric energy. An administration building is also planned.

Reactors for sale in the U.S.A. have just been announced by Babcock & Wilcox of New York. A water boiler and a swimming pool reactor type have been offered at fixed cost price of U.S.A. $ 100,000 and 150,000 each. Incidentally it has been found that experimental boiling water reactors of American design remain stable when boiling within the core is permitted, thus tolerating heavy fluctuation in power load. The newly created Atomic Industrial Forum with library centres in New York and other towns will be the centre where declassified information from the U.S.A. Atomic Energy Commission in Washington will become available to power engineers for study and research.

Experience on the two small stations generating about 100 kW will thus become available to American industry. Amongst the various plans for building nuclear power plants, the project of the Common-

Leo Walter, A. M. I. Mech.E., M. Inst. F., *is Consulting Engineer, England.*



Basic Scheme of Nuclear Power Station.

Fig. 1. Basic Layout of Atomic Power Station.

wealth Edison Co. of Chicago seems the most interesting. This generating plant will give a net output of 211,000 kW using natural uranium as fuel and 3 turbo-alternators of 80,000 kW.

Nuclear Fuel

Fuel experts in U.S.A. stated recently that the U.S.A. has about 950 billion tons of potentially recoverable coal in the ground, being about 1/3 of the total world supply. In theory this should last at the present rate of consumption for 200 years or more. As coal constitutes 84% of the known potentially recoverable mineral fuel reserves, and all shale, petroleum, natural gas and other fuels have to be added to this reserve, the future fuel outlook for the American industry seems bright. In practice, however, things seem somewhat different. First, the present rate of fuel consumption is bound to rise. Second, only about 1/4 of the 950,000,000,000 tons of coal are considered to be economically recoverable, and one day the point of diminishing returns will have been reached. Mineral fuels and water power together produced in 1952 in the United States contained heat energy equivalent to 8 horsepower per person per-day for the whole year, but is bound to rise. Experience in the past indicates a very sharp rise in the future, because the overall use of energy has quadrupled in the past 50 years and nearly doubled in the last 26 years. One day the need for nuclear industrial energy will have to be met in addition to dwindling natural fuels, and this explains why farsighted measures to develop atomic power stations in U.S. are fully justified in spite of present abundance of fuels.

The fuel position in Great Britain is less favourable than in U.S.A. A country running short of coal and with no oil or natural gas available, and with limited sources for water power is fully justified to look out for additional means.

Looking at Canada's fuel resources, the outlook seems much brighter. Water power, oil and natural gas and solid fuels are available in sufficient amounts to cover the needs of the country for many years to come. Obviously the incentive for building nuclear power plants is less pronounced than in other countries where the fuel position is or may become tense. As far as Canadian nuclear plants are concerned, not much is known to power engineers. Readers will recall that just before Christmas 1952 there was an accident to the NRX atomic pile at Chalk River, but this has now been rebuilt and greatly improved. It is known, however, that plans have been made for an experimental reactor for a power plant, based on the rich resources of natural uranium.

Among the South-American countries, Brazil possesses considerable Thorium sources and plans an experimental reactor for generation of electric power.

In Europe, Belgium intends to build a graphite moderated reactor for production of isotopes, and a reactor for generation of electric power, both based on big uranium fields in the Belgium Congo in Africa. Sweden is another European country possessing Uranium ores, and plans an atomic power plant. An overseas country where big Uramiun deposite are being exploited is Australia, and a nuclear power plant is planned.

Nuclear Plants in Great Britain

Taking into account the veil of secrecy which still masks various projects in most industrial countries, it can be stated that perhaps the greatest practical progress in building of atomic power plants has been made in Great Britain. Certain data have been released by the British Atomic Energy Authority and placed at the writer's disposal, which build the basis of this brief progress report.

Repeated statements made by Government Departments in Great Britain stress the fact that nuclear power stations are, and will always be expensive in construction, but fuel costs will become reasonably low in the not too distant future. Plants in the British Isle will operate at full load day and night so as to make the biggest possible saving of coal. In comparison of hydro-electric and nuclear power, M. Pierre Ailleret, Director of Research for Electricite de France said recently that with an interest of 4 per cent per annum a hydro-electric station with an economic life of 45 years will be economically equivalent to a nuclear power station if the latter cost 40 per cent (for a ten year life) or 65 per cent (for a twenty year life) of the cost of the water power station of the same capacity. As the capital cost per kW of a hydro-electric station is about four times the cost per kW of a thermal power station in France, these figures indicate that the nuclear power station becomes an economic competitor if it has a first installation cost equal to about 1½ times (for a 10 year life) or 2½ times (for a twenty year life) the cost of a thermal power station of the same size. In the opinion of this French expert the price per unit generated would be below that of a thermal power station, but higher than that of a hydro-electric station.

In Great Britain the authorities concerned assure future users that nuclear plants will produce electricity at the price of one penny per kWh (the present figure for the British Electricity is 0.7 pence/kWh). As regards possible cost of electric nuclear energy in Canada one can only venture to hazard a guess that they will keep near the figure given for Great Britain.

Comparing the figures spent in the United States for development of atomic energy it can be stated that Great Britain spends according to the resources available a considerable amount, which gives her a certain lead in production of atomic power. Approximate figures mentioned in the House of Commons in London when moving the second Atomic Energy Bill in 1953, are that whereas approximately 7,500 million U.S.A. dollars have been spent and another 2,500 million U.S.A. dollars allocated by the United

States Atomic Energy Commission, the respective amounts are over Pound Sterling 100 million spent during the first six years, 1946—1951 in Great Britain. Expenditure in Great Britain is now running at over Pound Sterling 50 million per year, mainly for production of radio-active isotopes and for research purposes.

The two British Atomic Plants under Construction

There can be no doubt that much will be learned from the first two atomic power plants to be built in Great Britain. The fast breeder reactor plant being built at Dounreay, Caithness in the North of Scotland will be self-supporting in atomic fuel supply (Fig. 2). Another power plant of 50 MW from plant operating in connection with the breeder reactor at Calder Hall, Cumberland will use two graphite-moderated, gas cooled, natural uranium reactors. Fig. 3 shows a model of this plant which will be described in the following in some detail. It has been officially stated that cost estimated indicate that the present design of nuclear power stations might have twice the capital cost of a conventional British Electricity Authority station. The water-moderated type of power unit, built for larger output, would be considerably cheaper with the result that the capital costs would be somewhat higher and fuel costs somewhat lower than for conventional stations.

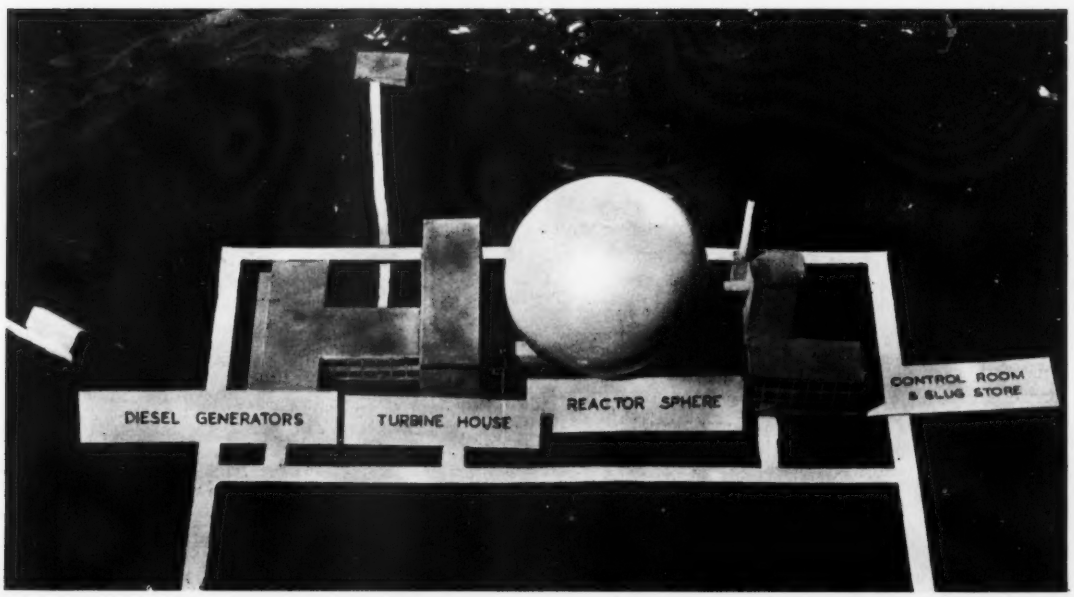
Reactors in Britain

The British Atomic Energy Organization was set up for research and commercial purposes in 1946. It operates the Research Establishment at Harwell, and the Production Division for Isotopes. Both establishments operate nuclear reactors. (Fig 4.) The first experimental pile BEPO was built at Harwell and completed in 1948, in form of a graphite-moderated, air cooled atomic reactor, using graphite rods for control of the nuclear reactions. It was followed later on by Zephyr, which is a zero energy fast reactor at Harwell, becoming critical for the first time on February 5th, 1954. This is the first fast reactor to be built in the United Kingdom. The objects of Zephyr are to obtain operating experience with a fast reactor and to gain information which can be obtained only by the actual operation of a reactor. This information will be of major importance to the design work on an experimental power producing fast breeder reactor.

The fast reactor has characteristics which make it likely that most of the uranium atoms in natural uranium can be consumed by the process known as breeding, whereby a nuclear energy electricity generating system operates with a much smaller supply of fuel than in the case of natural uranium or slightly enriched uranium thermal fission reactors. The advantages of fast reactors are therefore bound up with the cost and availability of uranium ores, and the principle of breeding is to create mo fissile material than is consumed.

The construction of a fast reactor requires pure, or nearly pure, fissile materials, so the construction of Zephyr could not be undertaken until this material was available. The fuel used is, in fact, plutonium enclosed in a metal can. The core of a fast reactor, i.e., the central portion containing the fuel elements, is very small and in the case of Zephyr only about the size of a top hat. The core is surrounded by a more massive envelope or blanket of uranium which

Fig. 2. Part of the scale model of Britain's latest Atomic power station which is soon to be built at Dounreay in the north of Scotland. The dominant feature of the plant is a steel reactor sphere, which is about 150 ft. in diameter and some 35 ft. above ground level.—*Br. Crown copyright*



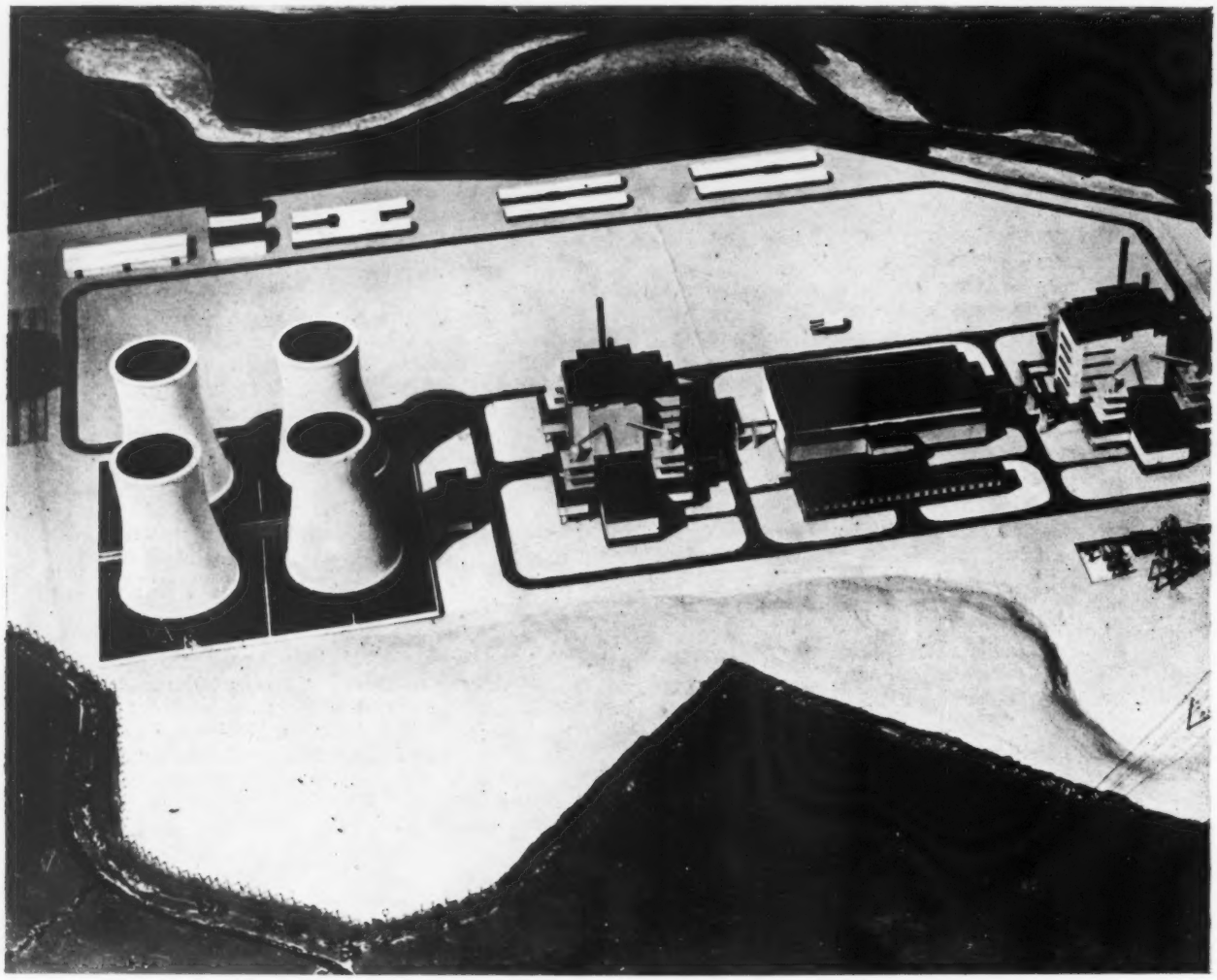


Fig. 3. Model of British Atomic Power Plant at Calder Hall, England. —*Br. Crown Copyright.*

either reflects back any neutrons escaping from the core or absorbs them so as to produce fresh plutonium. In this way very few neutrons are wasted.

The designation "zero energy" means that the reactor is to be operated at a very low power level so that it will not get highly radioactive and will not require cooling. As a result it should be possible to make modifications to the reactor from time to time in the light of experience which has been gained.

Britain's first heavy-water pile called DIMPLE has also come into operation at Harwell, mainly for experimental work. Its nickname is based on the initials of the title "Deuterium-Moderated Pile, Low Energy." The heavy water moderator is contained in a tank which is surrounded by a graphite neutron reflector. Outside this is a concrete radiation shield.

British Atomic Factories

The atomic factories operated from the Risley headquarters are located at Springfield for uranium production, at Windscale for plutonium production (Fig. 5) and at Capenhurst for uranium 235 production. The already mentioned new experimental atomic power station at Calder Hall is being erected alongside the plutonium factory at Cumberland, and is the fifth factory to come into operation. The sixth factory is the plant at Dounreay in Scotland and will produce electric power for the grid of the British Electricity Authority.

An important step in atomic development was the design and construction of a plant capable of producing uranium from the crude ore imported from the Belgian Congo. The Springfield factory was chosen for this purpose. It had originally been built and operated during the war for the production of poison gas. The factory was particularly well adapted to to the production of uranium, since it was already equipped with most of the necessary services and had many buildings suitable for offices, stores, and

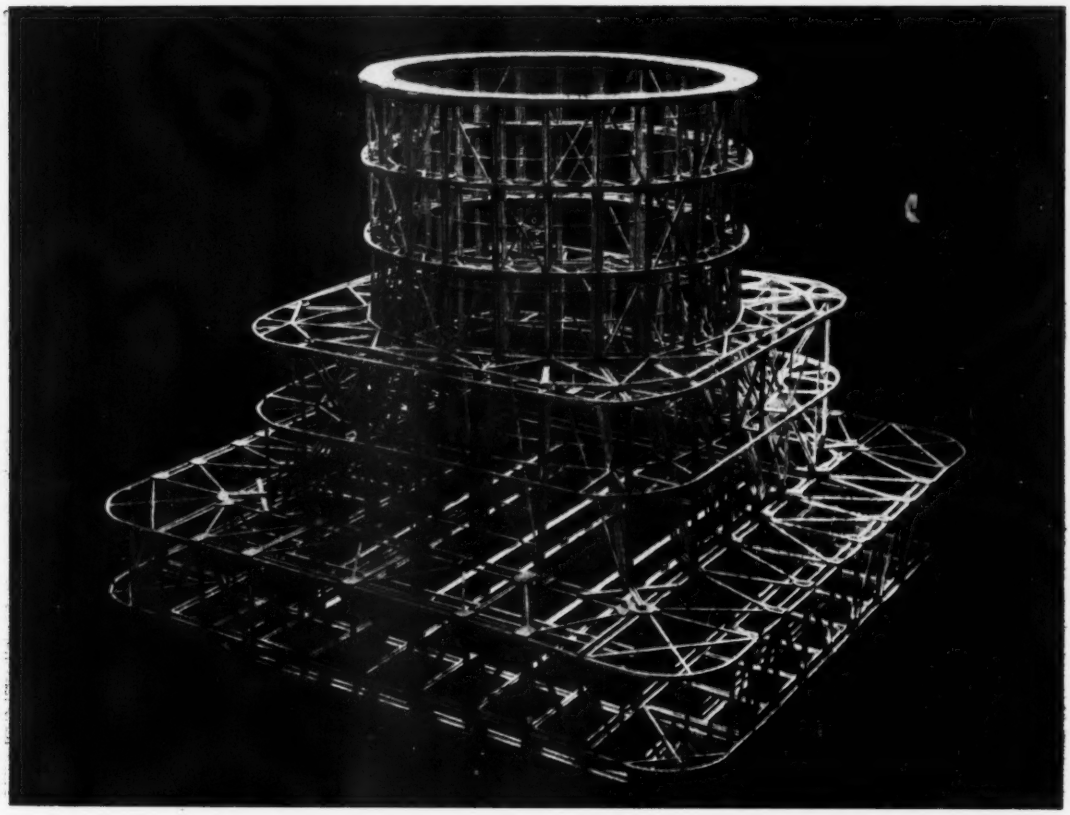


Fig. 4. Model showing upper structural work for BEPO Nuclear Pile at Harwell. *—British Crown Copyright.*

process work. It was taken over within a month of the formation of the Atomic Energy Production Division in 1946. The new uranium factory was designed, built, and brought into production in the planned time of 2 years. (Fig. 6).

In the process employed at Springfield—based on research conducted during and after the war by the General Chemicals Division of the Imperial Chemical Industries, Ltd.,—the uranium ore is crushed to a powder, dissolved in a mixture of acids, and treated with barium carbonate solution to precipitate radium and other metals present as impurities in the ore. Hydrogen peroxide is added to the solution containing uranium to precipitate uranium oxide. The latter, though pure enough by most standards, is sufficiently contaminated with neutron-absorbing substances to preclude its direct conversion to metallic uranium and to its use in atomic piles for commercial production. (Fig. 7).

Atomic Power at Calder Hall

In the atomic power station now under construction at Calder Hall in Cumberland the primary objective is to transfer the enormous quantities of heat released in fission to a boiler, and use the steam for generating electrical energy. Previously, in the production of plutonium for atomic bombs, this heat has been an unwanted by-product. Experiments have shown that by using a "Fast reactor" i.e., one in which the neutrons move at the high speeds they possess immediately on release from the nucleus, it is possible to produce a greater quantity of an equally efficient secondary fuel. This process is known as "breeding."

An example of a breeder system is a fast reactor charged with plutonium 239 as a fuel and with the reacting core surrounded by a blanket of uranium 238. Neutrons escaping from the core enter the blanket where they transmute the uranium 238 to more plutonium 239. The amount of fresh fuel bred in this way can exceed that consumed in the core of the reactor if care is taken to avoid waste of neutrons. With the new breeder reactors, it is possible to build up stocks of "artificial" secondary fissile materials made from uranium 238 and thorium.

In the application of the atomic "furnace" to steam generation for electric power production, an important item is the heat-transfer medium—which in the case of Calder Hall Plant will be carbon-dioxide gas under pressure. The reactor core will be enclosed in a mild steel shell, screened by a concrete shield. The boilers heated by the "coolant" gas (CO_2) will be placed around the reactor (as described later) and the superheated steam will be passed to a turbo-alternator of conventional design.

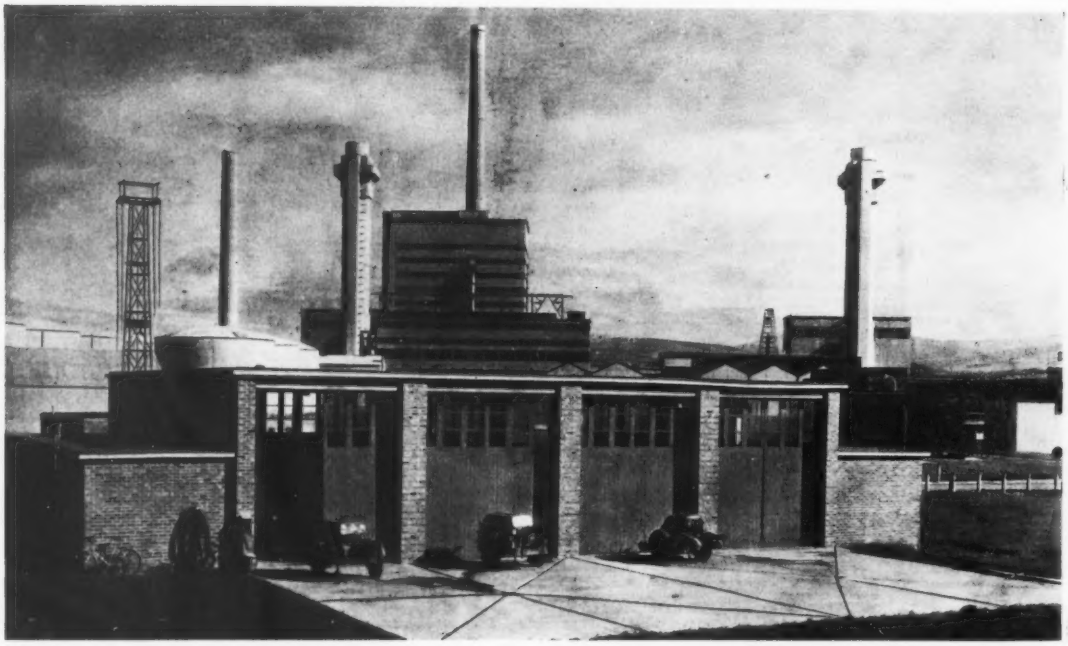
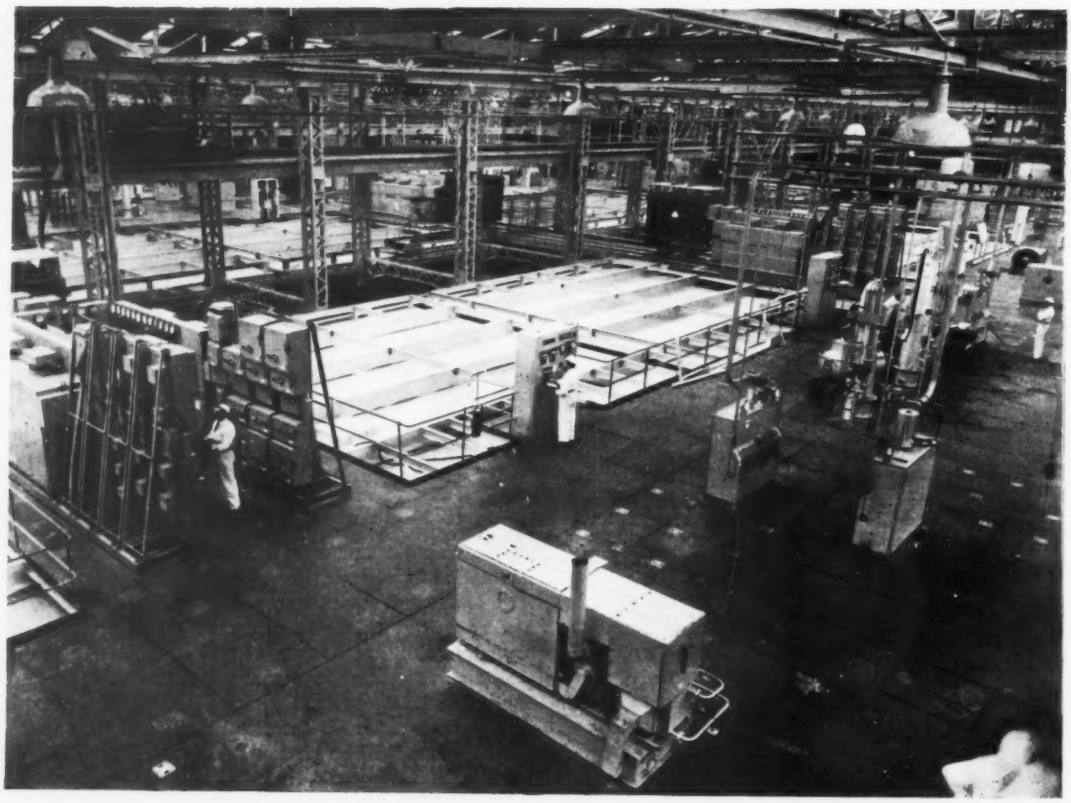


Fig. 5. A general view of Windscale Works. A feature of the factories is the fire fighting gear with which they are equipped. At the touch of a button some of the factories can be flooded with solutions capable of extinguishing the worst fire. *—British Crown Copyright.*

Fig. 6. On the control deck above the rows of plant cells at the Copenhurst factory. The instruments and controls regulate the plant below. *—British Crown Copyright*



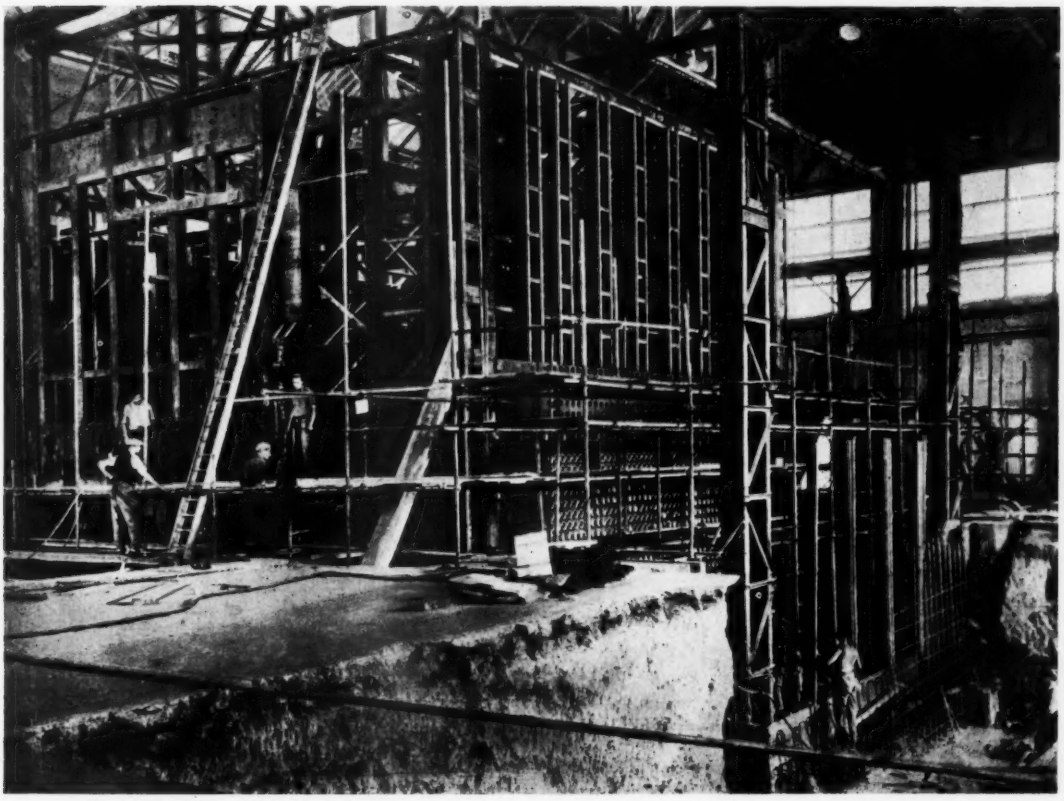


Fig. 7. Permanent Shuttering System for Atomic Pile. *—British Crown Copyright.*

From the economic aspect, a great deal will depend on reducing the cost of accelerating the chemical process of extraction of atomic fuel from breeder reactors. The Calder Hall power station has an initial advantage in that electricity cannot be debited with the whole of the capital charges, since plutonium for military purposes is to be produced as a by-product.

It was been decided to use graphite-moderated, gas-cooled reactors operating on natural uranium at the Cumberland Atomic Power Plant because this type provides inherent safety and stability, and because the core has a large thermal stability. Heat ratings, however, would be rather modest per ton of uranium, which would mean a rather large capital investment for uranium.

Other disadvantages may be the need for use of pure graphite for the moderator and safety shut-off rods and the difficulty in construction of the pressure shell—the latter being a cylinder approximately 30 feet in diameter.

Reliable operation is expected with a maximum surface temperature of the fuel elements of about 752° F. The gas-coolant circuit is under pressure (perhaps 100 psi). The core design of the reactor has vertical channels, and from the heat transfer and nuclear points of view, the coolant should be helium, carbon-dioxide, or nitrogen. The coolant gas will be circulated round the closed coolant circuit by motor-driven blowers, providing a gas outlet temperature of about 662° F. The heat exchangers or steam boilers could be located outside the main biological shield surrounding the reactor itself under these conditions.

The Steam Boilers at Calder Hall

The complete steam generation equipment for the new Calder Hall power station in Cumberland has been entrusted to Babcock & Wilcox Ltd., of London, England who produced an entirely new boiler design in co-operation with Harwell scientists and engineers. (Fig. 8).

The layout of the power plant comprises a central turbine house with nuclear reactors located at either end. Each reactor is associated with four steam raising towers approximately 80 ft. high which, with their vertical arrangment, suggest oil refinery practice rather than conventional boiler plant. Heat which is generated in the graphite-moderated uranium reactors is conveyed to the steam plant by carbon dioxide under high pressure ; the hot gas gives up its heat to preheating, evaporating and superheating sections of the steam plant. After passing through the steam raising towers, the cooled gas is re-circulated by powerful blowers back to the reactor, where the cycle is repeated. (Fig. 9).

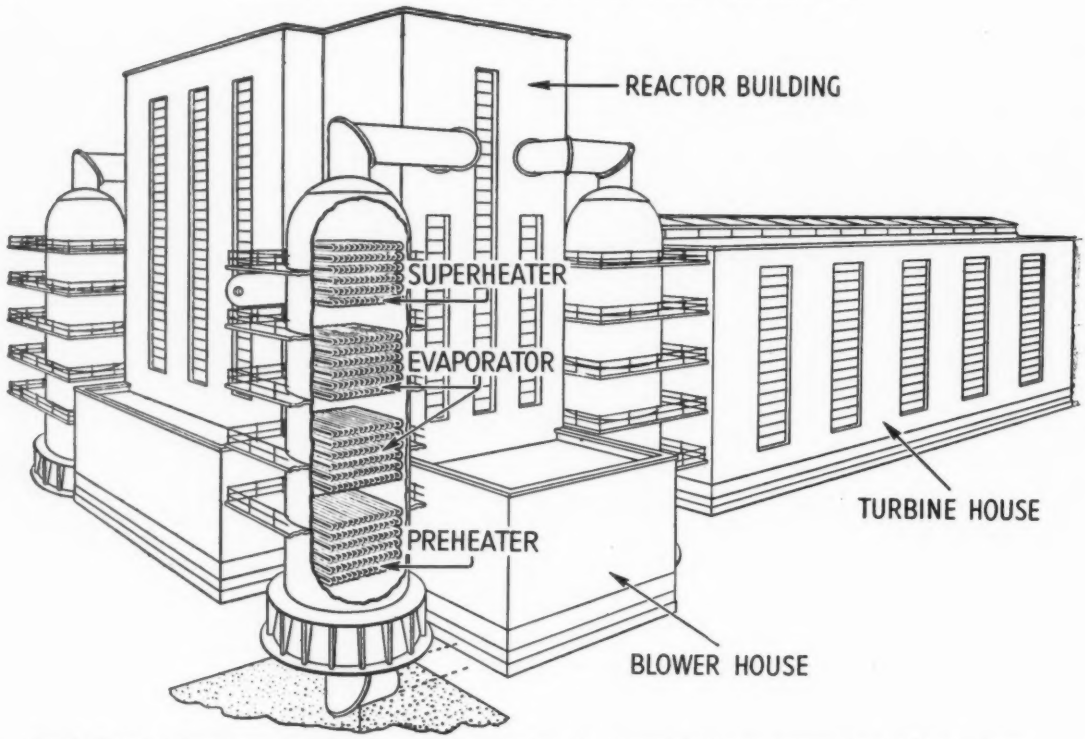


Fig. 8. Britain' First Atomic Power Station—Shown above is a drawing showing general principles of steam raising tower. The towers, totalling eight in number, each 80-feet high, are now under construction at the works of Babcock & Wilcox, Ltd. One of the most interesting features from a technical point of view is the use of a double-pressure steam cycle in order to obtain maximum efficiency from the comparatively low temperature (as compared with a conventional furnace) of the gas entering the steam towers. The reactors are being built by the Department of Atomic Energy.

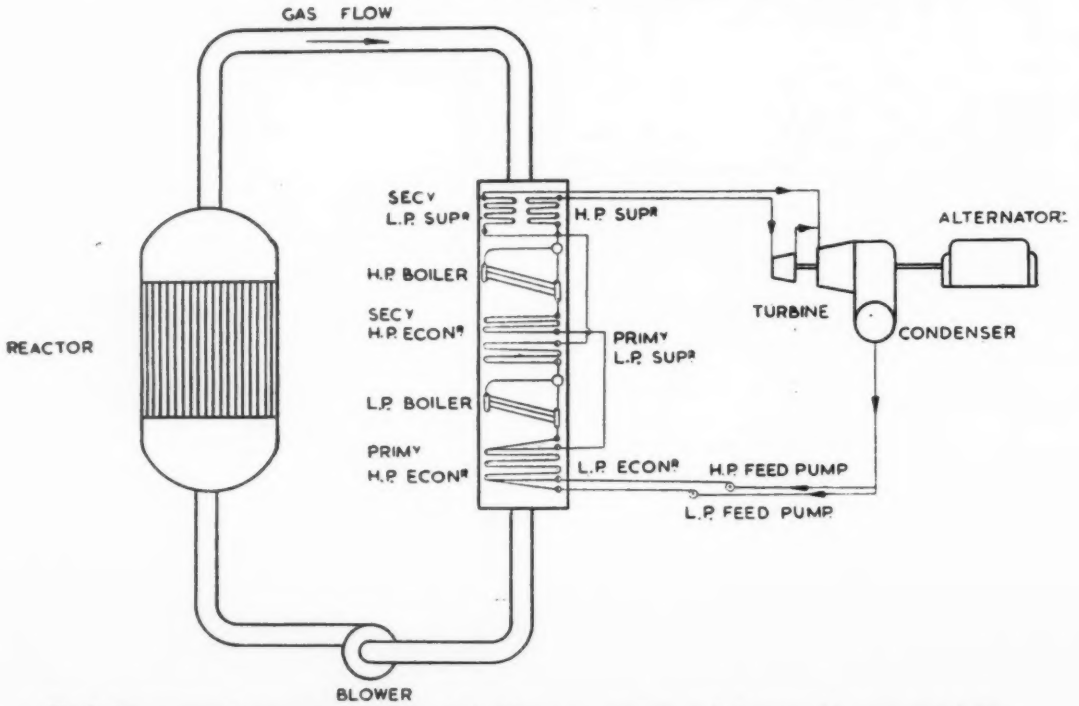


Fig. 9. Diagrammatic arrangement of simple double-pressure steam cycle for use with a gas cooled pile.

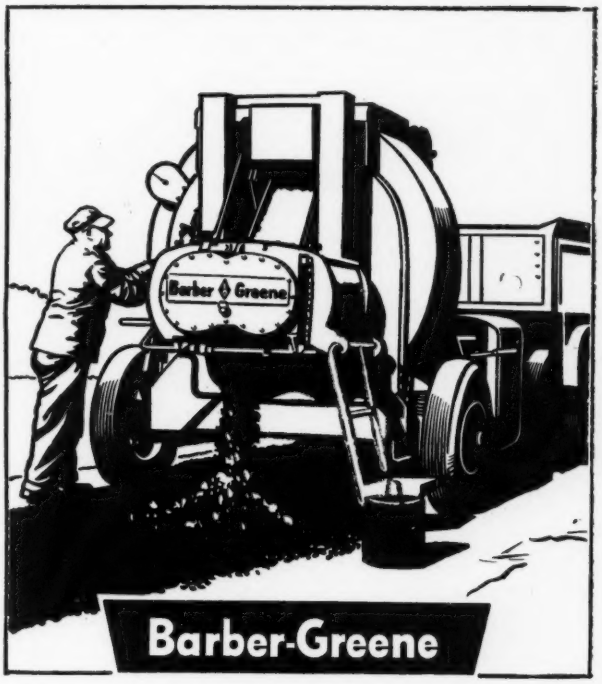
One of the most interesting features from a technical point of view is the use of a double-pressure steam cycle in order to obtain maximum efficiency from the comparatively low temperature (as compared with a conventional furnace) of the gas entering the steam towers. Each tower contains, in effect, two separate sets of steam-raising equipment, there being separate HP and LP economiser, evaporator and superheater sections, each with its own drum and feed pump. The turbine plant will of course be designed with a LP section which will receive live steam direct, as well as steam which has already been expanded in the HP blading. In order to obtain the maximum heat transfer within the towers all heating surfaces are of stud-tube construction to give extended surface. The studs are flash-welded and have smooth surfaces and a profile giving good aerodynamic properties.

An important requirement of the internal heating surfaces is that there should be no leakage of steam or water into the coolant gas, otherwise contamination of the internals of the reactor—the fuel elements and graphite—would result. The design therefore involves no joints inside the pressure shells except those which, once completed in the shops and exhaustively tested, will not be required to be broken throughout the anticipated life of the plant. In addition, the high pressure of the coolant gas (due to the need for economy in blower power) requires the whole system to be built to withstand this pressure without any possibility of leakage. It is not too much to say that the long experience of Babcock & Wilcox in the production of large fusion-welded pressure vessels to fulfil the most stringent requirements, has played a significant part in establishing the feasibility of a project of this size.

Another interesting feature of the station is of course, that it has no chimneys in the generally accepted sense, since there is no coal or oil being burned. Two comparatively small vent pipes are provided on each reactor house for extracting any heat loss from the reactor which is not transferred to the steam towers. Filter plant is provided to ensure that no atmospheric dust particles that—in spite of the most stringent precautions—might find their way into the reactor space, are discharged in a radioactive condition.

Future Prospects

The above British nuclear power stations under construction are certainly a most remarkable milestone in the road to utilising nuclear energy, but it seems only a beginning. New materials and methods might influence future designs, making them more compact and more efficient. Thermo-nuclear possibilities are vast, and it has been stated by Sir John Cockcroft, Director of the Atomic Energy Research Establishment at Harwell that "the energy of fusion of light elements will also be turned from destructive to peaceful uses and so provide a source of power without limits." In other words the world can expect that the enormous energy released when a hydrogen bomb is exploded will eventually be put to useful purpose.



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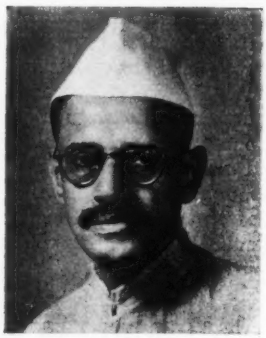
No. 101 B M.

Report of the Ministry of Irrigation and Power, 1954-55

G. L. NANDA

The 1954-55 has been a very busy year of activity for the Ministry of Irrigation and Power and the Central Water and Power Commission. This was mianly due to the plans and efforts made to check the danger of floods necessitated by the unprecedented floods in the year sweeping the entire sub-Himalayan regions. The impact of the floods was so great that a Central Flood Board was created and a Flood Wing of the CW & PC was set up. In cooperation with the parallel efforts by the States, the Flood Wing has put up a great work in such a short period of time. Another outstanding achievement of the Ministry was the holding of the Engineer's Seminar which greatly facilitated formulation and finalisation of policies concerning the administrative and technical problems experienced by engineers tackling the construction work in river valley projects.



AUTHOR

During the year under report, the Ministry was strengthened and reorganized in order to enable it to stand up to the strains imposed on it by the increasing tempo of work on river valley projects. An additional Deputy Secretary, two additional Under Secretaries and ancillary staff required to man four additional sections were appointed.

Flood Control

The unprecedented floods in 1954 caused extensive damage of life, property and communications, particularly in the North-Eastern region. As the measures taken by the States to combat floods were, generally speaking, merely palliative, Government decided to tackle the flood problem in the country on a coordinated basis in conjunction with the States. A satisfactory protection of the areas affected by floods required a more scientific approach involving concerted action by adjoining States in the collection of essential technical data. On the advice of the Centre, the States affected set up Flood Control Boards to formulate flood control schemes—energent, short-term and long-term—in their areas. These Boards are assisted by Technical Committees. To consider the schemes prepared by the State Flood Boards at the highest level and to draw up a National flood control programme, a Central Flood Control Board which includes Ministers from States and the Centre has been constituted. To assist the Central Flood Board in all technical matters pertaining to the preparation of integrated plans for flood control, River Commissions have also been constituted for the basin of the Ganga and Brahmaputra and for the North-Western region covering Punjab, Pepsu and Jammu & Kashmir. The Control Board has met thrice so far and has taken decisions regarding the nature of emergent works to be carried out. Extensive invesigations on the Himalayan rivers have been taken up. Negotiations are in hand with the adjoining States of Nepal, Bhutan, Sikkim & Tibet (China) for the collection of data in the upper reaches of the rivers. Plans for town protection works in Assam, West Bengal, North Bihar and U.P. have been drawn up and the work has been taken in hand.

International Activities

Shri Kanwar Sain, Chairman and Dr. K. L. Rao, Director, Central Water and Power Commission, visited China early in May, 1954, to study the flood control measures adopted by the Government of China on the Yellow-Yangtse river basin which presents problems similar to those found on the Kosi. Delegations were also sent to the Second Congress on International Commission on Irrigation and Drainage held at Algiers, Regional Conference on Water Resources Development held at Tokyo under the auspices of the E.C.A.F.E., and the 21st Congress on Large Dams and the Coastal Engineering Congress held in Grenoble.

Central Water and Power Commission (Water Wing)

To cope with the additional work connected with flood control, drawing up of specification of plant and machinery required for river valley projects and their standardisation, supervision of technical training centres, etc. the Commission was strengthened and internal reorganisation carried out.

Apart from the basic work pertaining to the development of river valleys, irrigation, hydro-electric power, navigation, etc. the Commission scrutinized 26 projects included in the First Five Year Plan and 24 projects proposed for inclusion in the Second Five Year Plan. Irrigation statistics are being collected from 1939 onwards to enable publication of triennial reviews. Existing schemes for drinking water supply in a number of cities and towns are being examined to suggest improvements to meet the increased demands for drinking water. A programme for the assessment of irrigation potential of the various regions of India has been drawn up and work has been taken in hand in certain basins.

G. L. Nanda *is Minister for Irrigation & Power, Govt. of India*

A monthly journal entitled "Bhagirath" is being brought out giving up-to-date information on the scope, programme and progress and extent of benefits of river valley projects under execution in the country.

The Central Water & Power Research Station at Poona conducted experiments on models and structures in connection with the various projects under execution. Among the important ones are: the Kosi, the Mahanadi and Brahmaputra River Models. Gandhisagar Dam and Kotah Barrage models. Experiments were also carried out on the models of Kandla and Mangalore Ports, Cochin Coast, Madras Harbour and the Hooghly River.

The Central Water and Power Commission (Flood Wing)

A separate Wing to deal specifically with flood problems has been constituted in the Commission under two Chief Engineers (one for Flood Investigation, and the other for Planning and Design). Besides helping to coordinate the activities of the States this Wing gives technical assistance to the States wherever neccessary.

Intensive investigations and surveys of river basins including aerial photographic surveys and levelling have been taken in hand. Three circles have been created for the purpose—one for the Assam rivers, a second for the Ganga Basin and a third for the rivers in the Deccan and Central India. Designs and drawing for Dibrugarh town protection works and alignments of embankments for Kosi were prepared. Specification drawings and designs for Hanumangarh Barrage are in hand.

Public cooperation has been enlisted in the construction of flood control works in Assam, Bihar & U.P. The response from the public in the Kosi area is particularly striking.

Projects under Investigation

Ukai Dam Project

Detailed studies were made on the Ukai Project and based on these studies, the first stage development of the Lower Tapi Basin has now been planned.

Barna Project (Bhopal)

From the preliminary studies, a site on the Barna river in Bhopal State has been located for the construction of a dam 123 ft. high, and canals with a gross commanded area of 2,50,700 acres for irrigation. Detailed investigations are in progress.

Kolar Project (Bhopal)

An irrigation-*cum*-hydro-electric project on the Kolar river for irrigation of 96,000 acres and generation of 15,000 kW of power prepared by the Bhopal Government was examined.

Tripura projects

At the request of the State Government, the C.W. & P.C. have agreed to investigate the possibilities of minor irrigation schemes and flood measures on the Haora, Gumati, Doe, Moni and Khatwa rivers.

Central Water and Power Commission (Power Wing)

During the year under review, the Commission continued work on the systematic assessment of the power potential of the country. Two volumes dealing with the power potential of (i) West Flowing Rivers of Western Ghats, and (ii) East Flowing Rivers of Southern India, have been completed. All these represent schemes which appear to be technically and economically feasible. Revised specifications and designs for the generating plant, and equipment required for the Gandhisagar Dam Power Station were prepared. Similar specifications and drawings have been prepared for the Tungabhadra Hydro-electric Project (Hyderabad). Assistance was continued to the Assam Government in connection with with the Umtru Project. Power projects prepared by State Governments for inclusion in the Second Five Year Plan were subjected to technical scrutiny.

Satisfactory progress has been made during the year on the planning and designing of the central steam power station for the supply of power to the Kandla Port and adjoining areas in Kutch State. A review of the load potentialities of the D.V.C. area was undertaken and a detailed report was prepared.

Assistance was given to several State Governments and other authorities in the preparation of power transmission schemes. The Commission has also undertaken the standardisation of transmission and distribution lines of electricity supply in rural areas in all States in order to achieve economies in the execution of rural electrification schemes.

Collection of technical and other data in regard to rural electrification development in the country was in hand. Schemes for electrification of small towns and rural areas in the various States costing about Rs. 20 crores were scrutinized.

Hirakud Dam Project

The first stage of the Project is in an advanced stage of construction. The revised estimate of Stage I amounting to Rs. 70.78 crores has been approved by the Government of India. Two schemes prepared in connection with the second stage, for irrigation in the Delta and genertion of additional power, are under consideration. The project will be substantially completed and power and irrigation water made available by August 1956. With the completion of Stage I, there will be additional production of paddy to the extent of 4.5 million maunds.

Damodar Valley Corporation

On the expiry of its first term, the Corporation was reconstituted on 5th April, 1954, with Shri P. S. Rau, as Chairman.

A. Work Completed during the Year

Konar

The construction of the Konar Dam was completed except for the erection of the Crest Gates. Water was stored for the first time in the Dam upto the top of the masonry crest level. The storage water will be utilised for use in the Bokaro Thermal Power Station as well as for irrigation in the lower valley.

Tilaiya

The Tilaiya reservoir was filled for the second year in succession and generation of hydro-electric power for commercial use continued.

Maithon

The progress of the construction of the Maithon Dam continued to be satisfactory although a setback of a few months occurred in the time schedule due to delay in obtaining certain essential plant and spare parts. The earth dam was raised to a sufficient height to allow the monsoon flow to be diverted through the spillway channel. The diversion tunnel opening was blocked at the mouth.

Panchet

The work at Panchet progressed satisfactorily. A steel trestle bridge across the spillway channel was completed for access to the dam during the monsoon period.

B. Barrage and Irrigation

The Barrage and Irrigation project in the lower valley made very satisfactory progress. The construction of the main barrage is expected to be completed ahead of schedule.

C. Electrical Department

The Bokaro Thermal Power Station and the Tilaiya Hydro-Electric Station, which had been commissioned in 1953, were in satisfactory operation during the year. The construction of transmission lines and substations was speeded up. The Government of India have approved the scheme for extension of the transmission system to Calcutta-Gaya-Dalmianagar and work has been taken up on a high priority basis.

D. Soil Conservation & Rehabilitation Department

Soil and water conservation of the Damodar Valley is an important and integral part of the main scheme. Conservation measures are necessary for the improvement of agriculture and for bettering the standard of life in the Valley. Some important measures were initiated in this regard.

The policy of offering land for land to persons displaced as a result of submergence continued. The rehabilitation of displaced persons at Bokaro and Tilaiya was completed. The rehabilitation at Konar is almost complete. Out of 4,602 families affected by the Maithon reservoir, 650 families desired to be resettled and the rest preferred cash compensation. An area of 1,500 acres has been reclaimed against the target of 2,500 acres by June 1956. Out of a total area of 100,000 acres needed, about 50,000 acres were acquired, the total cash compensation payable being about Rs. 5 crores.

E. Development Work

Three schemes *viz.* Lock Manufacture, Cold Storage and a Central Finishing Workshop for hand-forged items were sanctioned by Government. Other schemes like wood workshop and ceramic industry, are under active consideration.

F. Policies and Proposals for the coming Year

The Corporation has decided to embark on a more comprehensive soil conservation programme and for this purpose has provided for an additional expenditure of Rs. 5 lakhs in the budget for the next year. Efforts are being made to obtain the services of a whole-time expert on soil conservation. Agricultural demonstration work in the lower valley will also be expanded and more intensive publicity undertaken to popularise the use of irrigation water for double cropping. Expansion of departmental mechanised coal mining is also under active consideration to effect economy in the raising of coal for thermal power generation.

Tungabhadra Project

The Tungabhadra Board has been reconstituted to make it more compact and businesslike and invested with the powers of a State Government. On the Mysore-Andhra side, the dam has been completed except for the erection of the shutters which is in progress. Work on the spillway bridge on the Hyderbad side is also in progress. The Dam, including spillway shutters and the operation bridge is expected to be completed by December 1956. The target dates for completion of the Dam Power House and the Canal Power House are June 1956 and December, 1956 respectively.

Bhakra Nangal Project

Considerable progress has been made in the execution of this Project. The Nangal Dam, the Hydel Canal and the two diversion tunnels have been completed. The Bhakra Canal System was opened in July, 1954 for non-perennial irrigation. The Power House No. I with two units of 24,000 k.W. each, was put into commission on the 2nd January, 1955. The Power House No. II, with two further units of 24,000 kW each, is expected to be ready by December 1955. One unit of 90,000 kW will be installed at the Bhakra Power House. The question of adding to the generating capacity of the Project is under the consideration of the Government.

The river is now flowing through the right tunnel. There has been an increase in the tempo of work of excavation for the foundation of the Main Dam and for the coffer dams upstream and downstream. Most of the consideration plant on order has arrived and is under erection.

Perenial irrigation will start with the completion of the Bhakra Dam by the end of 1959. According to the last project report, which is being finalised, the Project is estimated to cost about Rs. 157 crores.

Kosi Project

The revised estimated cost of the Project is about Rs. 42.5 crores. The construction programme allows a period of six years for its completion but this period is likely to be shortened by public cooperation which has been in the construction of the embankments under the auspices of the Bharat Sewak Samaj. When the scheme has been fully implemented, it will provide irrigation to 13.97 lakh acres besides affording protection against floods.

Koyna Project

The estimated cost of the Project is Rs. 33.22 crores. The project envisages a dam 204 feet high across the Koyna and an underground power house with 4 units of 60,000 kW each i.e. with a total installed capacity of 240,000 kW at 60 per cent load factor. Preliminary works are in hand. Specifications for electrical machinery and equipment are under preparation.

Chambal Project

The project estimated to cost Rs. 48 crores (Stage I) is being executed jointly by the States of Madhya Bharat and Rajasthan and on completion of Stage I, will provide irrigation to an area of 14 lakh acres in the two States and generate 69,000 kW of power (installed capacity). Excavation of foundations for the Gandhisagar Dam started in 1953. Preliminary arrangments are under way. Detailed drawings for the barrage and canal system and the lay-out and design of the power station have been prepared.

Rihand Dam Project

This Project consists of a dam across the Rihand river and a Power House designed to house 6 generating sets of 40,000 kW, one of which will be a standby. Rihand power will be available to the Eastern parts of U.P. The estimated cost of the project is about Rs. 45 crores. Power will be utilised for the operation of 4,000 tubewells for the irrigation of 16 lakh acres in U.P. and 5 lakh acres in Bihar and for large scale industrial development. A small block of the Power generated will be given to Vindhya Pradesh for industrial and domestic use.

Programme of Permanent Improvement in respect of Scarcity Areas

Schemes costing approximately Rs. 40 crores have been included in the First Five Year Plan. An additional area of about 1 million acres is likely to come under irrigation at the end of 1955-56.

Delhi State Electricity Board

During the period April-October 1954, the maximum demand on the Board's generating plant was 42,072 kW which exceeded the safe generating capacity by 2072 kW. The first block of power from Nangal of 10,000 kW is expected in April 1955 and another block of 10,000 kW towards the end of 1955.

In the Southern Zone, the electrification of Kalkaji and Malaviyanagar colonies and the extension of LT distribution to Juliana Village and Harinagar Ashram have been completed. In the Western Zone, the electrification to all colonies on Najafgarh Road, Tilaknagar and West Patel Nagar is nearing completion. The scheme for electrification of Gandhinagar, Krishen Nagar and Azad Nagar, in the Eastern Zone, will be taken in hand shortly. The other colonies in which electrification work has been carried out are : Malkaganj, Rupnagar, Bandstand Area and Shaktinagar.

The capacity of several existing sub-stations was augmented and a few new sub-stations were commissioned. The total expenditure on capital works amounted to Rs. 63.25 lakhs.

Indo-Pakistan Canal Water Dispute

The efforts of the Indus Basin Working Party to prepare an agreed plan for the maximum utilisation of the Indus system of rivers did not meet with success. The International Bank finding that further discussions were not likely to prove fuitful, drew up a plan and presented it to the Working Party. While the Government of India generally accepted the Bank proposal, it was not accepted by the Government of Pakistan. The talks, therefore, ended in a breakdown. The Government of India, however, informed the the Bank of their readiness to consider new arrangements for working out a comprehensive Plan on the basis of the Bank proposal as soon as Pakistan accepted it. They also offered to enter into an agreement for a transitional period which would enable developments to proceed in both countries on an agreed schedule as envisaged in the Bank proposal.

At the instance of the Bank the two Governments agreed to resume discussions for the purpose of working out, without commitment, and for consideration by the two Governments, a detailed engineering plan for the use of Indus waters, taking the division of waters proposed by the Bank as a starting point. Discussions have been resumed from December 6, 1954, in Washington on the basis of certain new terms of reference proposed by the Bank.

Committees, Conferences, etc

Engineers Seminar—Coordination Committee of Engineers—Coordination Board of Ministers

To ensure speedy implementation of decisions taken at the Engineers Seminars, a Coordination Committee of Engineers and a parallel Coordination Board of Ministers have been set up.

The second Seminar was held at Roorkee in July 1954 and was presided over by the Minister of Irriga-

tion and Power. Recommendations were finalized on the Report of Plant and Machinery Committee, Standardisation of Progress Reports, Soil Conservation, Rural Electrification and Eradication of Corruption. The recommendations were considered by the Coordination Board of Ministers at their first meeting on the 14th October, 1954. Amongst the more important decisions taken was the acceptance in principle of the policy of standardisation of important items of earth-moving equipment as recommended by the Plant and Machinery Committee. A Standing Committee of experts has been appointed to examine the question more fully.

Mahanadi Bridge Committee

The Report of the Committee was submitted to the Public Accounts Committee of Parliament for their consideration along with the views of the Government on the Bridge Committee's finding. The recommendations of the Public Accounts Committee in the matter are contained in their 11th report. This report is under the consideration of Government.

Construction Plant and Machinery Committee

As already stated the report of the Committee along with the recommendations of the Engineer's Seminar was discussed at a meeting of the Coordina- Board of Ministers and one of its main recommendations in regard to the standardisation of important items of earth-moving equipment was accepted in principle.

Rates and Costs Committee

With a view to examining the rates of major items of work prevalent on the various River Valley Projects and preparing a comprehensive schedule of rates to be adopted as a basic schedule for all projects with such modifications as may be necessary for local conditions and a standard analysis of rates for the main items, a Rates and Costs Committee was set up in February 1954. In consultation with the Comptroller & Auditor General, the Committee has also been asked to make recommendations on the Stores Accounting Rules, P.W.D. Forms, etc, to be adopted for large projects. The report of the Committee is expected to be received by Government shortly

Technical Personnel Committee

With the inclusion of additional schemes in the Plan and the consequent increase in the tempo of work during the next 10 to 15 years the need for taking steps to make a realistic assessment of the technical manpower position in the country was felt by Government. An Expert Committee was, therefore, appointed in July, 1954 to go into the question and its report is expected shortly.

Training

As an immediate measure to meet the shortage of trained engineers for river valley projects, a scheme has been sanctioned to train 30 fresh engineering graduates and 15 serving officers from the State Governments of the Hirakud, Bhakra and D.V.C. Projects and in the C.W. & P.C. Training Centres are also proposed to be opened to impart training to operators, mechanics and foremen in the operation and maintenance of heavy earth-moving equipment used on river valley projects.

State Electricity Board and Amendment to Electricity (Supply) Act, 1948

An inter-State Conference was held on the 10th February, 1955, to discuss the administrative and and other difficulties in the way of the establishment of Electricity Boards in the States. It is expected that as a result of the deliberations of the Conference, the States where no Boards have set up will take steps to constitute them in the near future.

Certain amendments proposed to the Electricity (Supply) Act, 1948, as a result of the experience gained in the working of the Act within the last six years were considered at an inter-State Conference held in February 1955.

Meetings with Members of Parliament

Meetings are being arranged regularly with Members of Parliament from different States to discuss irrigation and power projects in the States concerned. The working of the various projects is reviewed in a general way and criticisms and suggestions of members are invited. Discussions at these meetings are of an informal nature and have proved useful.

An informal Consultative Committee of Parliament has also been set up to discuss matters of importance pertaining to the execution of irrigation and power projects and other cognate subjects.

Silting Of Machkund Reservoir

In a written reply to a question Shri Jaisukhlal Hathi, Deputy Minister, Irrigation and Power, said that the Machkund Hydro-electric Project had been threatened with silt deposits.

Detailing the steps to be taken to arrest the soil erosion of the catchment area, the Deputy Minister added: "The Andhra Government have reported that the problem of prevention of soil erosion in the Machkund reservoirs is proposed to be met in two ways: (1) by including silt settling and exclusion devices in the designs of the works and (2) as far as feasible by creating and preserving a covering of vegetation and forest in the catchment and by regulating the cultivation so as to retain the surface soil. In regard to item (1) the State Government of Andhra are considering a proposal of the Chief Engineer (Electricity) to construct at a cost of Rs. 14 lakhs the diversion dam overflow section of the Jalaput Dam as a barrage with a lower crest level up to 2,570 feet and with gates of 20 feet height, instead of a solid dam up to 2,500 feet, so as to store water up to 2,590 feet level. In regard to item (2), besides the construction of check dams, revetments, etc., the State Government propose to draw up a comprehensive scheme of soil conservation which will include contourbunding and terracing, gully plugging, and afforestation in the catchment area. Out of a total amount of Rs. 11 lakhs provided towards soil conservation and rehabilitation of displaced families in the revised estimate sanctioned by the Government of Andhra, an amount of Rs 1 lakh has so far been spent on soil conservation measures."

Chambal Valley Development, Madhya Bharat

A. K. CHAR

AUTHOR

That the Chambal Valley Project is one of the most important river valley projects there should be no doubt. The river flows through rich regions of tin and zinc mines whose needs for electricity are of national importance. When in the Second World War the British lost their hold on Burma, the Chambal Valley Project was concieved. But as soon as the immediate urgency was removed, the matter was shelved. Now that India is free and that this dry region is no longer divided into innumerable princely States, the Project has been included in the very first 5-year Plan. The following contribution by the Chief Engineer of the Project outlines the Project and its progress.

The river Chambal is one of the main tributaries of the river Yamuna. It originates near Mhow (at an elevation of 2,800 ft above M.S.L.) in Indore District of Madhya Bharat State and flows in northerly direction for about 200 miles before entering a gorge in Malwa Plateau near the place called Chaurasigarh Fort. After this, it flows through a gorge about 40 miles long and then enters the alluvial plain near Kotah. From the origin upto about 206 miles, it flows exclusively through the Madhya Bharat State. Beyond this it forms the boundary between Rajasthan and Madhya Bharat for considerable length. A further stretch of its course lies in U.P. for the last few miles of its journey before its confluence with river Yamuna near the town Etawah at an elevation of 400 feet above mean sea level. The total length of river Chambal is 600 miles.

Although this river valley has substantial water potential no investigations were carried out before 1945. When Burmah was occupied by the Japanese during World War II, it was contemplated to use the Chambel waters to generate Hydro-electric Power required to work the Zawar mines of the then Udaipur State for Tin and Zinc. As Burmah was re-occupied by the allied forces, before the scheme took shape, no further steps were taken to harness the waters of the Chambal. After this, the individual States of Kotah, Mewar and Indore prepared a number of schemes mainly for power development and to a small extent for irrigation purposes. But none of the schemes could be finalised owing to inadequate resources at the command of the States. By 1948, however, these small States had merged into two bigger units namely Rajasthan and Madhya Bharat. The Government of India, therefore, conferred with the two Governments in the same year and finalised the blue print of the co-ordinated and integrated project.

A. K. Char *is Chief Engineer, Chambal Hydel Irrigation Shceme, Madhya Bharat*

The present proposal of development of the Chambal River Valley envisages construction of three Dams and a Barrage. The first Dam in the series is called Gandhi Sagar Dam at present financed by the Government of Madhya Bharat. It is located about five miles down-stream of the the Chaurasigarh Fort mentioned above. The second Dam called the Rana Pratap Sagar Dam is located at a place called Rawat Bhatta in Rajasthan about 20 miles down-stream of the first. The third Dam called the Kotah Dam will be located about 20 miles down-stream of the second Dam. The Barrage called the Kotah Barrage will be located about two miles up-stream of the Kotah City. The second and third dams and the Kotah Barrage are at present being financed by the Government of Rajasthan.

The whole development will be carried out in three stages as mentioned below :

First Stage

This envisages the construction of Gandhi Sagar with Gandhi Sagar Power Station, Kotah Barrage, the entire Canal System and a portion of Transmission Line System. The cost of these works is as detailed below :—

1. Gandhi Sagar Dam.	Rs. 8.90	Crores.
2. Gandhi Sagar Power Station.	Rs. 5.00	,,
3. Kotah Barrage.	Rs. 3.07	,,
4. Canal System.	Rs. 22.52	,,
5. Transmission System.	Rs. 8.54	,,
TOTAL	Rs. 48,03	Crores.

After the completion of the first stage, 11 lakhs of acres of land will be irrigated and 75,000 k.W. of power will be generated. The power will be sold at 0.8 anna per unit at the Grid Sub-Station.

Second Stage

In the second stage the Rana Pratad Sagar Dam

and the Power Station to generate 90,000 k.W. of Power at 60% load factor will be constructed and correspondingly transmission lines will be extended. The total cost for this stage is estimated at Rs. 13.66 crores. This will add an additional area of 3 lakhs of irrigation bringing the total irrigated area to 14 lakhs of acres.

Third Stage

In the third and final stage will be taken up construction of Kotah Dam with Power Station to generate 45,000 k.W. of power at 60% load factor and further extention of transmission lines. This stage is estimated to cost about Rs. 10 crores.

Thus the full development of the Valley is estimated to cost Rs. 71.69 crores and the scheme will yield an annual return of 7% on the total outlay. The ultimate benefits after complete development of this Project are :—

(1) *Irrigation of land*

(*a*) In Rajasthan	..	7.00 Lakh Acres.
(*b*) In Madhya Bharat	..	7.00 Lakh Acres.
TOTAL		14.00 Lakh Acres.

(2) *Generation of Hydel Power*

(*a*) At Gandhi Sagar Dam	75,000 k.W.	@ 60% Load-factor
(*b*) At Rana Pratap Sagar Dam	90,000 k.W.	,, ,,
(*c*) At Kotah Dam	45,000 k.W.	,, ,,
TOTAL	210,000 k.W.	@ 60% Load-factor

The other minor benefits will be rise of water table at places round the lake margin, availability of sea-plane base, development of fisheries and general rise in the level of prosperity of the country.

Gandhi Sagar Dam

The salient features of the Gandhi Sagar Dam are enumerated below :

(1) *Site of Dam*

On the River Chambal in lat. 24°-44′ longi 75°-33′, 19 miles North-West of Bhanpura and 5 miles down-stream of the mouth of gorge in the boundary of Madhya Bharat and Rajasthan.

Nearest Railway Station—Jhalawar Road on Broad Gauge Bombay-Delhi Line (Western Railway) is 32 miles by road from the Dam Site.

(2) *Catchment Area* 8,700 square miles.

(3) *Rain-fall*

(*a*) Maximum rainfall 52 inches (1944)

(*b*) Average annual rainfall 34 inches for 47 years period.

(4) *Run-off*

(*a*) Maximum (in 1944) 9.522 million acre ft.

(*b*) Minimum (in 1918) 0.828 -do-

(*c*) Average of 47 years 3.680 -do-

(Corresponding to 3″ run-off over the entire catchment).

(5) *Flood Flow*

(*a*) Maximum observed 6,41,000 Cusecs.

(*b*) Maximum design flood. 7,50,000 Cusecs,

(*c*) Moderated flood adopted for design of Dam. 4,84,000 Cusecs,

(6) *Dam*

(*i*) Type. Straight Gravity.

(*ii*) Profile

	Non-over flow section	Over-flow Section	Power Section	Sluice Section
(*a*) Front	1 : 13	1 : 16.1/3	1 : 13	1 : 16.1/3
(*b*) Rear	7.1 : 10	6.7 ; 10	7.1 : 10	6.7 : 10
(*iii*) Width at top.	21 ft.	-	30 ft.	38.5 ft.
(*iv*) Maximum width at bottom	164.2 ft.	175.8 ft.	164.2 ft.	175.8 ft.
(*v*) Maximum height above foundation.	204 ft.	171 ft.	204 ft.	209 ft.

(*vi*) Length of the Dam.

(*a*) at top bank R.L. 1324 Between the 1685 feet

(*b*) at M.W.L. & R.L. 1312 ,, 1650 ,,

(*c*) at bed R.L. 1120 1250 feet.

(*vii*) Area submerged.

(*a*) at F.R.L. & M.W.L. R.L. 1312. 223 sq miles.

(*b*) at Minimum Draw Off level R. L. 1250 50 sq. miles.

(*viii*) Nature of Dam: Stone Masonry in red cement mortar and cement concrete around openings.

(*ix*) Contents of Dam: 27 Million Cubic Feet.

(7) *Flood Disposal.*

(*a*) Over the Dam: Spillway controlled by 10 Crest Gates 60′×28′ each, Crest Level at 1284.00

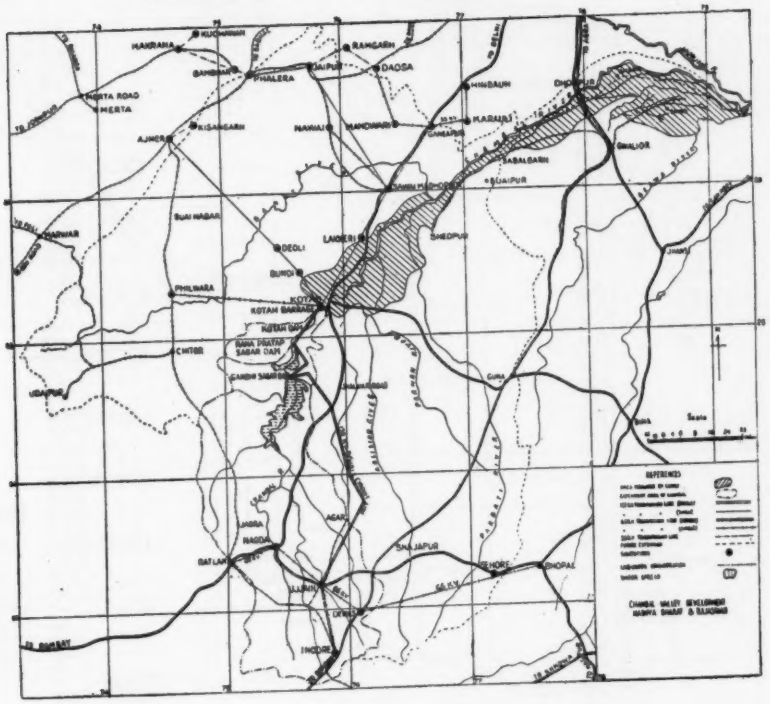
(*b*) Through the Dam: Nine high level sluices 10′×25′ each, sill level 1193.50.

(8) *Reservoir Levels*

(*i*) Average bed level of river	EI. 1120.00
(*ii*) Road on top	EI. 1324.00
(*iii*) Top of parapet	EI. 1328.00
(*iv*) Crest of weir	EI. 1284.00
(*v*) Full Reservoir Level	EI. 1312.00

Fig . 1 Facing page 16

Chambal Valley Development, Madhya Bharat.



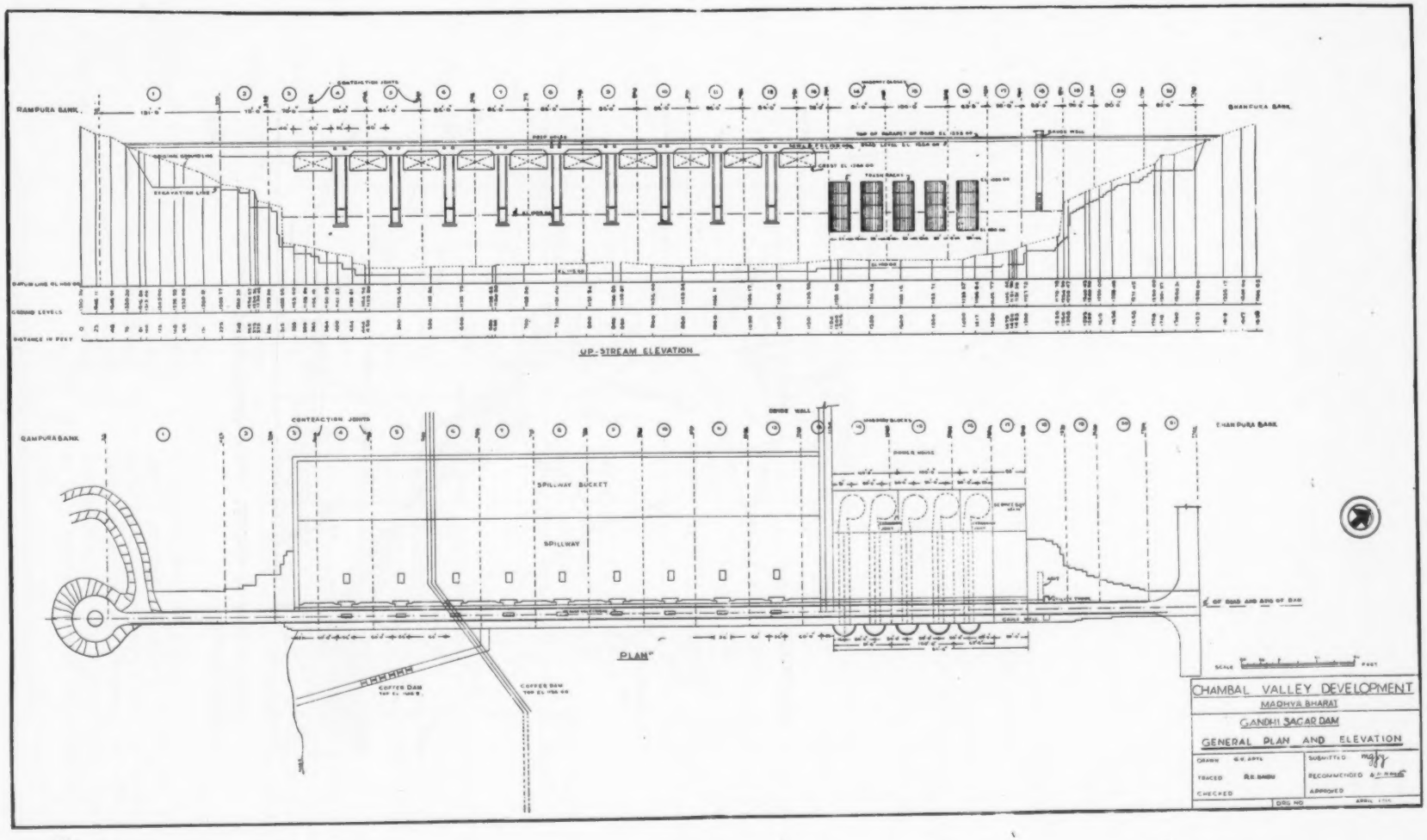
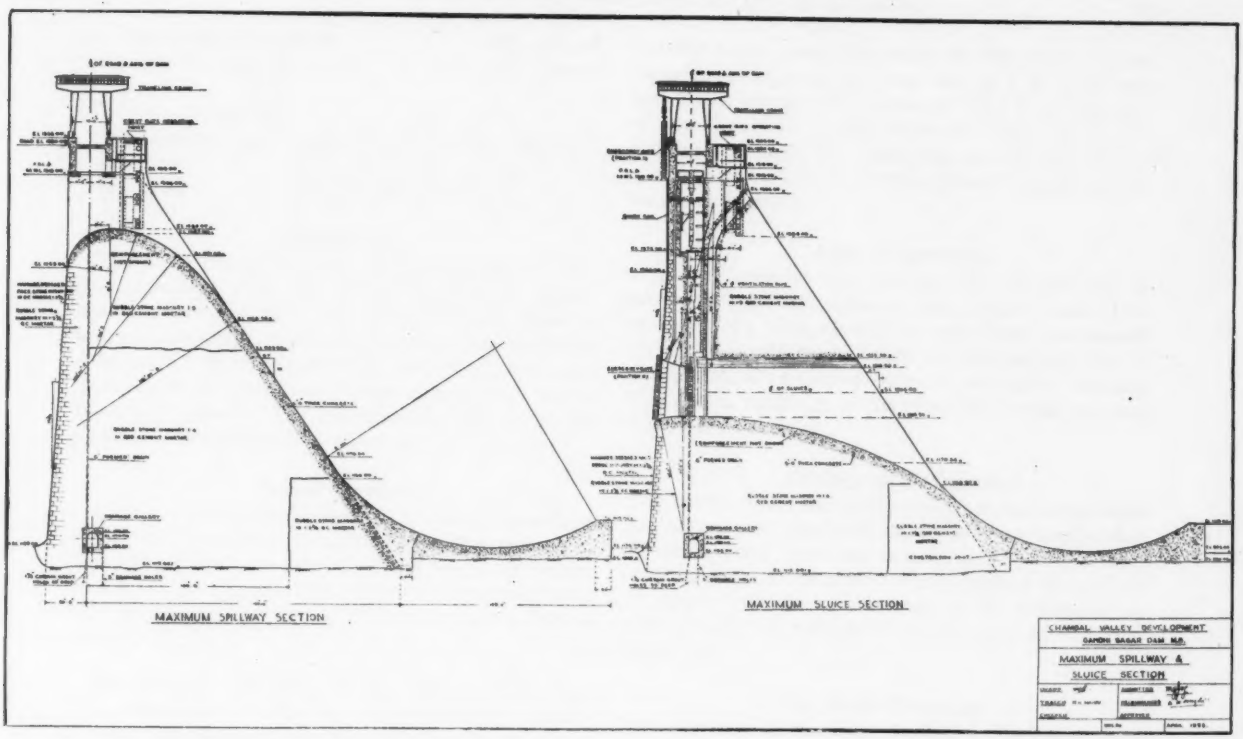

RAMPURA BANK
CONTRACTION JOINTS
BHANPURA BANK
UP-STREAM ELEVATION
SPILLWAY BUCKET
SPILLWAY
PLAN
COFFER DAM
CHAMBAL VALLEY DEVELOPMENT
MADHYA BHARAT
GANDHI SAGAR DAM
GENERAL PLAN AND ELEVATION

Fig. 2

Fig. 3


MAXIMUM SPILLWAY SECTION
MAXIMUM SLUICE SECTION
CHAMBAL VALLEY DEVELOPMENT
GANDHI SAGAR DAM M.P.
MAXIMUM SPILLWAY & SLUICE SECTION

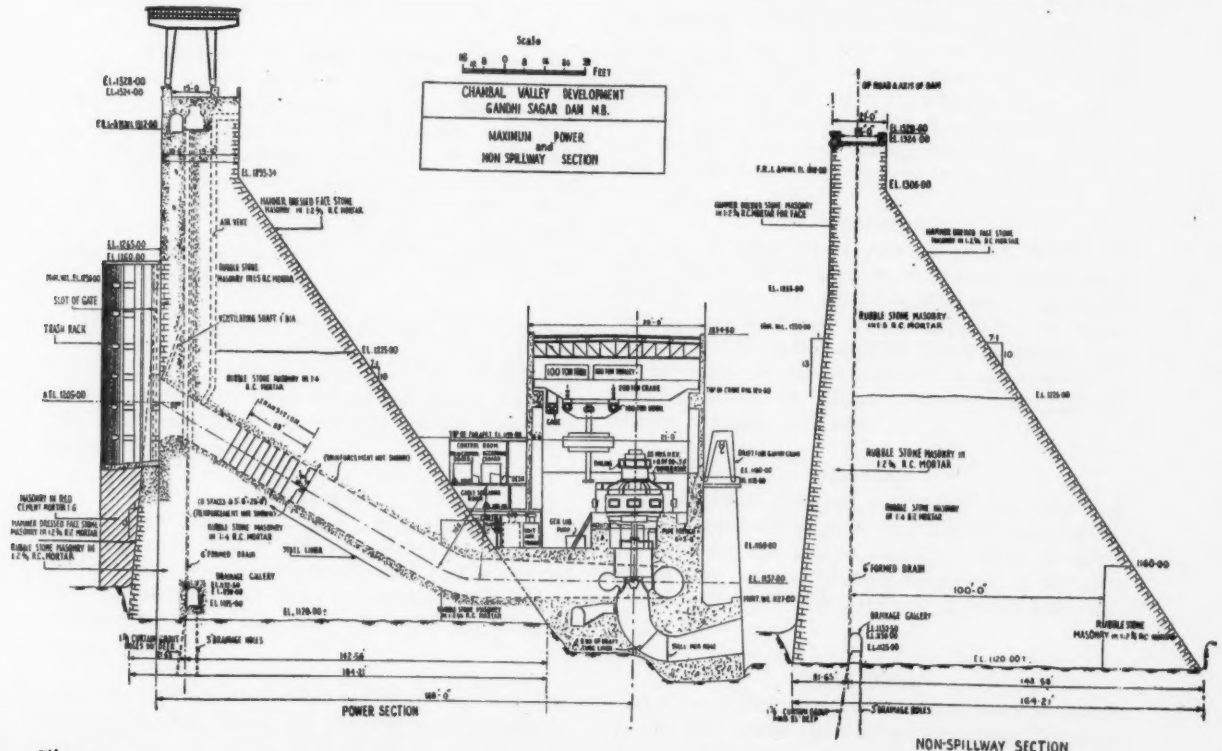

Scale
FEET
CHAMBAL VALLEY DEVELOPMENT
GANDHI SAGAR DAM M.P.
MAXIMUM and POWER NON SPILLWAY SECTION
POWER SECTION
NON-SPILLWAY SECTION

Fig. 4

(*vi*) Maximum water level EI. 1312.00
(*vii*) Dead Storage level EI. 1250.00

(9) *Storage Capacity*
(*a*) Gross Storage 2,49,598 M.C.F. or 5.73 M.A. Ft.
(*b*) Live ,, 2,20,414 M.C.F. or 5.06 ,,
(*c*) Dead ,, 29,185 M.C.F. or 0.67 ,,

Catchment

The total catchment area of Chambal River upto its confluence with the River Yamuna is 55,000 square miles and that upto Gandhi Sagar Dam is 8,700 square miles. The latter drainage area resembles a rectangle. On the South East, and West, the basin is bounded by Vindhian Range and on the North-West by Aravalis. The catchment is mostly a flat plateau either covered by black soil or alluvium.

Annual Rum-off

Like other peninsular rivers the Chambal discharges considerable volumes of water during the monssons. The flow in the dry weather dwindles down to a trickle. Hence the development of irrigation and power from this river is not possible without adequate artificial storage.

The average rain fall on the catchment is 34". The catchment is "average" as per Strange's classification. The average annual run-off works out to be 3.68 million acre feet at Gandhi Sagar Dam Site.

Gauge and Discharge Measurements

The day to day discharge in the river is being gauged at a place called Sujanpura, 13 miles upstream of the Gandhi Sagar Dam Site. The cross sections of river at this place are taken year after year and areas found out. The surface velocities are observed by means of surface floats, the mean velocities being calculated by multiphying by 0.8 to the surface velocity. The area and mean velocity and discharge curves are then drawn.

The river is being gauged since 1945. The maximum observed flood discharge is 6,11,000 cusecs whereas as per Inglis Formula 7,000/m ; theoretically discharge comes to 6,50,000 cusecs. For design purposes the maximum flood of 7,50,000 cusecs has been assumed.

Silt Studies

Silt observations on Chambal River were made in the year 1946. Nearly 70% of the area draining into the river is made up of retentive black cotton soil and the silt load brought down during the flood waters indicate that the silt charge is only 750 parts in 1,00,000.

Actually provision for silting for 100 years as per Khosla's recommendations for silt reserve namely 0.75 acre ft. per square mile of catchment has been made.

Area and Capacity

As will be seen from the saleint features of the Gandhi Sagar Dam the reservoir will have a gross capacity of 5.73 million acre feet at F.R.L. 1312.00 and water spread 1,63,800 acres. The Live Capacity of the Reservoir (above Elevation 1250.00) is 5.06 million acre feet. The Dead Storage of 0.67 Million acre feet below this level being allowed for silt reserve mentioned above.

Land Acquisition

In all, lands of 204 villages will be affected on account of the formation of the Gandhi Sagar. Out of those 120 villages will be completely submerged and the rest villages will partially submerged. Out of a total area of 1,63,800 acres 7,000 are under holding. The rest is made up of unculturable jungle ravines, rivers, etc.

Geology of Foundations

In the river bed the strata consists of hard quartzitic laminated rock. On the flanks there is an overburden of earth, hard moorum mixed with boulders etc. over the rocky layer at about an elevation of 1250.00. In general the rock is considered by Geologist as quite sound and suitable for resting the dam of this height on.

The River Diversion

At the site of the dam during the post monsoon period the river flow bifurcates into two branches, one branch on Bhanpura Flank and the other on Rampura Flank. The post monsoon discharge varies anything from 3,000 to 4,000 cusecs in the month of October to almost nil in the summer (May). However, in order to negotiate this flow alternately from one branch to another during construction, suitable Coffer Dams have been and will be constructed.

Excavation

In the river bed where quartzite rock is exposed to surface the foundation will be excavated to an average depth of 10 feet. On the flank after removing of the overburden mentioned above, excavation to about five feet into the sound rock i.e. below elevation 1250 will be made. Similarly necessary excavation to the designed levels for Power Station and Spillway buckets will also be made.

Grouting

Consolidation grouting with 1.7/8" diameter and 20' deep holes will be done in the entire foundation. The holes are also spaced about 20' apart. In addition to this curtain grouting up-stream of the axis of Dam with 1.7/8" diameter and 60' deep holes will also be made.

Head Work

The Gandhi Sagar Dam is a stone masonry structure 204 feet high above the average river bed (Elevation 1120.00). The length of the dam at top will be 1685 and at bed 1250 feet. The maximum width at the bottom in the spillway portion will be 175.8 feet and non-spillway 164.2 feet. (As per drawing showing the various cross sections of the Dam). The

Masonry of the dam will be in red mortar (one part of Surkhi powder plus four parts of cement plus sand), the proportion of red cement to sand being $2\frac{3}{4}$, 4 and 5 as the case may be.

Surplussing Works

The Dam is provided with 10 Crest Gates each of 60′×28′ (with sill at an elevation 1284) and with a total discharging capacity of 3,20,000 cusecs and 9 Regulating Sluice Gates each 10′×25′ (with sill at elevation 1193.5) with a total discharging capacity of 1,64,000 cusecs. Thus out of 7,50,000 cusecs assumed discharge, 4,84,000 cusecs will be surplussed through the gates. To negotiate the remaining 2,66,000 cusecs the reservoir will be depleted to elevation 1808 or so before advent of high floods.

An R.C.C. Drainage Gallery 5 feet wide and $7\frac{1}{2}$ feet high with a semi-circular arch on top with form-drains 6″ diameter will also be provided to take care of seepage water.

It is also proposed to install various instruments such as strain meters, stress meters, uplift pressure gauges, etc. in the body of the Dam.

Gandhi Sagar Power Station

The Gandhi Sagar Power Station will be 311 feet long and 70′ wide. It will house five Francis Type Generators each of 23,000 k.W. capacity out of which four will be running and one will serve as a standby. The total power generated at this Station will be 75,000 k.W. at 60% load factor. This will yeild a gross revenue of Rs. 176.25 lakhs annually at a rate of 0.8 of an anna per unit of power sold at the Grid Sub-Station. The net return on this account is expected to be over 4% on the sum at charge in the 16th year of starting of the Project.

Transmission Lines

From Gandhi Sagar Power Station a 132 K.V. Double Circuit line will be laid up to Ujjain, a distance of 100 miles. Indore will be connected to Ujjain through a 30 mile 66 K.V. Double Circuit Lines. A 175 mile 66 K.V. single Circuit line will connect Dewas, Bhopad and Ratlam with Ujjain.

In Rajasthan a 132 K.V. Double Circuit line of 67 miles will be provided from Gandhi Sagar Power Station to Kotah via Rana Pratap Sagar. This will cater for loads of Jaipur and Ajmer areas.

Canal System

The Kotah Barrage, the last structure in the series, will raise and divert water for irrigation in the canals. From the Barrage will take off two canals called the Left Main Canal and the Right Main Canal.

Left Main Canal

After taking off from Kotah Barrage the Left Main Canal will run for two miles after which it will bifurcate into two branches namely the Bundi Distributory and the Kaperen Branch. The Bundi Distributory will irrigate 96,000 acres and Kaperen Branch 1,64,000 acres annually.

Right Main Canal

Taking off from the Kotah Barrage the Right Main Canal carrying a discharge of 6,880 acres passes through the Rajasthan State for the first 79 miles of its length. At its 80th mile at the crossing of Parvati River this Canal enters the Madhya Bharat territory. At this place it carries a discharge of 3,900 cusecs. After this it passes entirely through the Madhya Bharat State. The Main Canal after the crossing of River Parvati runs as a contour canal for 103 miles where from takes off the Ambah Branch carrying 1125 cusecs and the Main Canal after this point is called the Main Canal Lower. The Main Canal Lower carrying a discharge of 1900 Cusecs flows a further length of 49 miles and thereafter will tailoff into the ridge canal called the Morena Branch Canal to irrigate the lands between the valleys of River Kunwari and the Assan River. At the end of the Main Canal Lower where it changes into a ridge canal a feeder canal carrying 1000 cusecs takes off and drops into the Asan River. The existing Pilua weir down-stream of Asan picks up the waters of the Chambal and diverts into the Kotwal weir on the Sank River by the existing connecting canal. From the Kotwal weir the existing Bhind Canal System takes off which is to be remodelled for the higher discharge required for increased irrigation under its command. A new canal called the Mau Branch Canal will be constructed to take off from the Bhind Canal.

The Ambah Branch Canal as mentioned above, takes off from the Main Canal at 103rd mile and carries a discharge of 1125 cusecs. It runs as a ridge canal irrigating lands between the valleys of the Chambal River and the River Kunwari. The length of this branch canal is about 112 miles.

The Right Main Canal and all its branches and distributories in the Madhya Bharat State when complete will irrigate a total area of 7 lakhs of acres annually in the Districts of Morena, Bhind and Gohad of Madhya Bharat State. The entire canal system will be completed in the first stage of development. The Right Main Canal (in Madhya Bharat) travels through a difficult terrain intersected by deep ravines and has to negotiate with a number of major cross drainages of which the biggest ones are the Parvati and the Kunu Rivers. The alignment of the Main Canal runs for a very considerable length close to the Gwalior-Seopur Light Railway Line. This is advantageous for the movement of labour and materials during construction and transport of the produce after the completion of the irrigation work. The salient features of the Right Main Canal are as under :—

Salient Features of the Right Main Canal

G.C.A.	..	16.25 Lakh Acres.
C.C.A.	..	10.23 ,, ,,

(*Continued on page 22*)

Economising in Cost of Projects

K. B. KHUSHALANI

The following contribution deals in general outline with an important subject for consideration of all construction engineers today. The various heads under which expenses are incurred are : Materials, Transport, Labour, Machinery, Supervisory Establishment, Taxes, Contractor's Profit, Wastage and Pilferage. All these have been considered by the author in brief. Suggestions for adopting correct policies to ensure efficiency as well as economy have been made. Fullest use of labour and curtailment of contractor's profits have been carefully noted. We are sure that the contribution will provoke thought among engineers.

AUTHOR

Economies effected in design and planning will often be far in excess of those that can be obtained through proper execution. But except for some general principles, design of each project is a problem by itself and cannot be covered by a general note of this nature. Similarly the lay-out of construction plan with respect to the site of works, existing communications and quarries have to be planned separately for each project and cannot be described in much detail here. In this note, it will therefore be presumed that a project is properly designed and planned.

While a bad design and planning may go unnoticed for the obvious reason that not many can criticise or have time to go into their details, but the high costs paid on construction even though they may be trivial as compared to the extra expenditure due to bad design and planning come into lime light simply because many are conversant with them, and also as waste is more abhorent to nature than a bonafide mistake from an undeveloped mind. Besides since the economies in construction are of general application to various projects, this paper confines itself to treating only this aspect of the question.

Items of Cost

In order to be able to find out various possible items of economy, it is necessary to analyse the cost projects and to see what are the items constituting it and the possible source of wastage. The cost of a project comprises of:

(*i*) Materials : Materials are of two types.

(*a*) *Principal materials*
They get into the construction and form a part and parcel of the structure just as stone, brick, sand, cement, lime, timber, steel, etc. Actually material by itself has no cost and is available free in nature. It comprises of labour and taxes or royalty in bringing it to a particular stage. What is the raw material for a particular industry may be finished product for another—just as stone is a raw material for cement factory and cement is its finished product while for a River Valley Project cement is a raw material.

(*b*) *Accessory materials*
These only help in construction just as blasting powder used for quarrying, oils and lubricants consumed in running the machinery, centering to provide temporary support etc.

(*ii*) Transport.
(*iii*) Labour.
(*iv*) Machinery.
(*v*) Supervisory establishment. This is of two types. One is departmental and the other is the contractors'.
(*vi*) Taxes.
(*vii*) Contractor's profit.
(*viii*) Wastage and pilferage.

General Rules for Economy

Before dealing with each item separately it is better to study some common rules which affect all items :

(*i*) The most important point is quick payments. Though everbody appreciates quick payments but this point can not be too much emphasised in case of Projects where a large percentage of people which constitutes labour is low-paid. It saves them interest charges of the money lenders and high prices paid in taking things on loan. Much more than that is the contractor who gets handicapped if bills are not paid to him quickly. Money in circulation increases outturn. With the same amount several times more work can be done if proper circulation is maintained. The account rules should be so framed that while observing the usual safeguards, there should be no delay in payments. There are 3 systems of audit—Pre-Audit, Post-Audit and Concurrent Audit. Post audit system is usually employed on maintenance works while on Projects either pre-audit or concurrent audit system is used, more generally the former.

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But the advantages of the latter are considerable. The concurrent audit consists in simultaneously auditing the bills in the Divisional Office by a representative of Audit Office with their preparation in the office of the Executive Engineer. Once the reputation of a Project in this respect is established the contractors will be automatically quoting low rates.

(*ii*) In suitable cases, contractors of repute may be asked to furnish their alternative designs along with the tenders.

(*iii*) Labour should be fully engaged. In contrast to the workmen engaged on industries the labourers on Projects have not got their assured livelihood. Everyone must have enough money to have two meals a day and some clothing and for that a certain minimum income is necessary. If he is engaged throughout the month less daily income will do and to that extent the labour will prove to be cheaper. But if forced hours of idleness are imposed on him naturally his daily wage has to be increased to raise the monthly income to the required level. Efforts should be made to keep the labour fully engaged on all days excepting for normal recreation or rest days like Sundays. Often a contractor will lose on the job if his labour is not employed on all days as unlike Govt. he has often to pay them a part of wages even when it sits idle.

The usual reasons why labour sits idle are :

(*a*) Land acquisition proceedings are not initiated in time so that the Project Authorities cannot enter the land. This is a common cause and the experienced engineer should start well ahead of his programme.

(*b*) Surveys are not completed in time so that the contractors cannot start the work. Number of cases in which delay occurs due to incomplete surveys is generally as great as due to land acquisition.

(*c*) Where machinery forms one of the items in the chain of operations, its break-down often causes labour to sit idle. There should be stand-by machinery in case of small units but for large units special care should be taken in providing sufficient number of spare parts in proportion to the frquency with which they break so that they can be easily replaced. Also in case of serious breakdowns there should be alternate work provided to keep the labour fully engaged.

(*iv*) Workmen should not be housed too far away from the job, otherwise by the time they reach the the site they may be partially or fully exhausted. Such of the people as have the facility of conveyance should be housed farthest. Lower paid a man is near the work he should be.

(*v*) Arrangements of supply of good and wholesome food stuffs should be made to see that his health is not impaired. His good health will prove to be a source of economy in the end.

(*vi*) Proper water for drinking should be provided in addition to copious supply for bathing.

(*vii*) To control Malaria regular war against the mosquitoes should be carried out. In this respect all the precautions for Malaria control should be taken and a Malariologist with adequate staff should be engaged to continuously look after this work.

(*viii*) Proper arrangements for sewage disposal should be made. Where the labourers are averse to using latrines, large areas marked by flags should be set apart for squatting and proper number of sweepers should be engaged to keep the area clean. Sufficient number of guards should also be stationed to see that the labourers observe the rules.

(*ix*) The Labourer should be given a living wage. It is pennywise pound foolish policy to curtail wages below what are absolutely necessary to keep the body in a healthy state. The wage should be sufficient not only to keep the body and soul together but be enough to give proper nourishment to him so that he can be made sturdy and strong which is going to reflect in higher turn out. In this respect it may be pointed out that a little extra nourishment to an under-nourished man can multiply his capacity for work for which otherwise two or more such labourers would be required.

(*x*) A few nurses engaged at cretches will save considerable time of women labourers who can attend to their work wholeheartedly; otherwise they simply draw the full wage and put forth hardly 1/3rd of the work.

(*xi*) Some comforts such as cold water supply during summer, sheds for rest in the noon and good showers for baths will enable him to relax his nerves and recoop his energy during the period of rest. While the labourer by his nature is rough and should not be softened too much by comforts a few simple amenities will certainly increase the out-turn.

To avoid strikes it may be necessary to be very vigilent in not giving employment to mischevious characters. While healthy voicing of grievances should be welcome, chances of unnecessary obstruction from self-seeking people should be cut out.

Economy in Various Items

After discussing the general rules the source of economy in various items can now be tackled.

(*i*) *Materials*

It may not be possible to effect any material savings in the factory cost of standard materials like steel

and cement, yet by selecting their source transportation charges may be decreased so that their cost at the project site reduces.

The cost of other materials which are locally had can only be drcreased by competition. A thorough study of available materials at site will repay several times its cost on such investigations. It may be that a material may be available very near but it may also be that either expenditure in working it up may be more or its strength be not as good as of another material at a distant place. Therefore a detailed study should be made and the ecnomies of the various available types of a material should be properly studied.

(*ii*) Railways, motor vehicles, belts and animal transport should all be considered for various items. In general for long distances and heavy materials transport by rail will prove cheaper but for short hauls and comparatively lighter material motor transport may be more feasible. For continuous feeding at short distances belts are employed. On the other hand bullock carts may work cheaper for stray works as they will save the cost of making metalled roads and in case of very small leads.

(*iii*) *Labour*

Properly trained labour for the job though it may demand higher wages may ultimately prove cheaper than raw and untrained people even though the latter may be apparently less costly.

(*iv*) *Machinery*

A large variety of machines for each type of job from different makers is now available. Adequate experience is required to select a right type of machine. What sometimes appears cheap at outset may ultimately prove to be source of trouble and delays and consequencent annoyance and extra cost. It is not the initial cost of the machinery but its life i. e. depreciation charges and running expenses, that should all together be considered in determining which type is suitable and is likely to prove cheaper in the end. The type of oil used by this machinery and its availability is another consideration which determines its choice.

(*v*) *Supervisory establishment*

The contractors are generally shrewed and they select proper people who can do their job cheaper and quicker. Besides they are free to employ or discharge any unsuitable man at will. Different is the case with Governments who are bound by certain rules. Therefore any mistake made in selection cannot be easily rectified. An intelligent man is worth thousands of mediocre and lakhs of duffers. His few tips may save millions. But only intelligence is not required. There should be grit, push and resourcefulness for a construction job. Once the right type of people are selected half the work is done.

(*vi*) *Taxes*

No reduction is possible in case of taxes.

(*vii*) *Contractor's profits*

Contractors profit may often form a very large percentage of the cost to curtail which the following steps should be taken :

(*a*) A good Sub-Division Officer and surordinate generally keep a watch on the contractors expenses to see what each item is costing him. This should be a regular feature of the project. The contractor's accounts should be periodically analysed and sudden checks sometimes applied to see what is the actual cost to him. Such a study will not only be useful to the Department but to the contractor himself. Often it may be possible to suggest him the source where he can economise just as reducing number of men on a job, increasing the out turn of his machinery and the number of trips of his vehicles, tractors and other moving equipment by following certain tips.

(*b*) *Standardisation*

At present the description of items varies from project to project as for instance for earth the basic lead and lift are 50′, 60′, 100′ and 5′, 6′ and 10′ respectively. This affords no comparison between various projects. Besides the description of soils also is not standard. Common soil at one place may be clay, at another loom and at third silt. More precise description of the soils should be given and description of the various technical organisations should standardise these description which should be followed on all projects. Items should be basic which are common all over the country. The varying items should be as few as possible and even from them the common parts should be taken out. Not too much emphasis can be laid on this aspect of the question as the standardisation will lead to proper check, competition and ultimate saving in the cost of projects.

(*viiii*) *Wastage and pilferage*

While wastage may be considerable, pilferage seldom constitutes a major item. The pilferage can only be reduced by proper watch and ward system.

To curtail wastage occasional checks at various stages of construction should be applied to see what quantity of material is put in and how much is utilised.

In short a thorough and concious vigilence continuously maintained will affect considerable economies.

(*Continued from page* 18)

Annual irrigated area	..	7.00 ,, ,,
Length of the Canal	..	152 Miles.
Maximum Discharge at the Parvati River Crossing	..	3900 Cusecs.
Maximum bed width	..	126 Feet
Maximum Depth	..	9.5 Feet.
Free Board	..	3 Feet
Bed Slope	..	in 10,000
No. of Major Cross Drainages	..	12 Nos.
No. of Minor Cross Drainages	..	181 Nos.
Crop Pattern	..	70% Rabbi. 20% Rice. 5% Sugar Cane. 5% Cotton.
Cost per acre of commanded area	..	Rs. 127.5
Cost per acre of irrigated area	..	Rs. 186

The estimated cost of the Irrigation System in Madhya Bharat is Rs. 13.04 crores and is expected to be complete by 1963.

Progress to the end of January 1955

Gandhi Sagar Dam

All the preliminaries such as Surveys, Location of Site, Geological Investigations, Model Experiments, etc. are over. The designs have been finalised and a combined Project Report by both the States namely Rajasthan and Madhya Bharat has been prepared and approved by the Contral Water and Power Commission. The Planning Commission have now included this Scheme in the First Five Year Plan. The work of excavation for the foundation of Dam was started on 26th January, 1953 at the hands of Shri. V. V. Dravid, Hon'ble Minister for Development and Labour, Government of Madhya Bharat. The total excavation done to the end of December, 1954 is about 25 lakhs cft. This work is going on pretty fast.

The foundation stone for the dam was laid by Pandit Jawahar Lal Nehru, Prime Minister of India on 7th March, 1954. Since then about 8 lakh cft. of masonry to the end of January 1955 has been constructed. This work is also going on in full swing.

Construction machinery such as Cableway, Mixing and Batching Plant etc. total costing about Rs. 50 lakhs is being obtained through the T.C.M. In some cases the orders have also been placed and the machinery is expected to arrive in two to three months' time.

More and more staff has been and is being recruited to cope up with the volume of work and to be able to keep to the construction programme. At present over 3000 labourers are working at the Gandhi Sagar Dam Site.

Irrigation (Right Main Canal, Madhya Bharat)

Preliminary surveys including the aerial surveys have been completed and the main canal alignment has been finally fixed. Detailed surveys for branches and distributories are also nearing completion. Excavation ceremony of the Main Canal was inaugurated at a place called Shripura, 22 miles away from Sheopur at the hands of an old farmer on 11-2-1954. Dr. K. N. Katju, Home Minister, Government of India who was to inaugurate the function could not come on account of certain unavoidable reasons. Shri. V. V. Dravid, Hon'ble Minister for Development & Labour, Government of Madhya Bharat was, however, present to grace the function. At present over 1000 labourers are working on this work.

The designs of the Parvati Aqueduct have been finalised in consultation with the Central Water and Power Commission and the tenders called for have been opened and are under consideration for finalising and fixing of contract.

Construction machinery such as Shovels, Motor Scrapers, Crawler Tractors with Bull Dozers, etc. total costing about Rs. 150 Lakhs is being obtained through T.C.M. In some cases purchase authorities have also been issued.

This major scheme taken by the Government of Madhya Bharat will after completion lead the people of its State to prosperity and plenty in respect of electrical power and food which is the present days' greatest and the most urgent need of the country to win the economic freedom.

Problem of Corruption in Hydro-Electric Projects

Mr G. L. Nanda made a frank assessment of the problem of corruption in major hydro-electric projects in his reply to the debate on the Irrigation and Power Ministry's demands in the Lok Sabha.

He admitted that some degree of corruption was prevalent, but claimed that measures taken to check it were proving increasingly susccessful. He also denied most of the numerous charges relating to the Bhakra-Nangal project made during the debate, except those about construction of the canal network.

This had been done in a great hurry, he said, and there had been some irregularities. Investigation was proceeding and first estimates of the loss incurred was about Rs 10 lakhs out of a total expenditure of Rs 100 crores.

The Minister said he had personally inquired into, and had found no truth in the allegations that as a result of blasting, the sites of the Bhakra dam and the power house had to be shifted. The dam site had not been changed and while the power house site had been shifted, it was for other reasons, he said.

In all, however, he admitted that there was "not a clean atmosphere" at Bhakra owing to charges and counter-charges being made by interested parties.

Review of Methods of Accounting and Audit in Project Organisations

R. S. VANKATA RAMIAH

The systems of accounts and of audit specially with reference to the P.W.D. procedure have been intriguing many an engineer engaged in river valley projects. The recent meetings of the Engineers' Seminar at both Nangal and Roorkee have discussed some of these questions and it has been generally realised that the present procedures and methods are antiquated and ill-fit with new situation created by the organisation of river valley projects. Cost accounting is also an important aspect of the present requirements. Mr. Venkata Ramiah here discusses the present methods and their inadequacies and suggests a more modern "integrated" accounting organisation which should prove useful to the authorities of river valley projects.

AUTHOR

Somehow the convention in many industrial organisations has been that cost accounting is entirely a different sphere from that of financial accounting. Based on this, separate set up for cost accounting and cost audit is generally recommended and this branch is made to work as a separate unit collecting the information from the figures compiled for the purpose of financial accounts. In several industries, particularly works organisations, separation of cost from financial accounts is hardly necessary if a system of integrated accounts is organised. In consonance with the modern system of having one common set of account books for both cost and financial accounts, works and projects land themselves as very good examples for such integration. In this system, the accounts can be compiled on costing principles which would help the accounting and audit on the "cost" basis itself, in addition to financial audit like check of vouchers, sanctions, classifications, etc.

System in Government Departments

This type of organizations is followed in Government works deartments in that the accounts are compiled work-wise initially and then taken in the books of the Accountant General according to the budget heads to place them before the Legislature. The estimate sanctioned by the competent authority is the basis for the check of actual expenditure incurred against the works. The estimate is prepared in accordance with the standards fixed in the schedule of rates. Thus the importance is given to the principle of standard costing. Stress is given more on watching the excess over the total estimated cost of the "Original Work" or "Repair Work" or at best on the "Sub-heads" of works wherever deemed necessary as in the cost of Major Works. Thereby, the unit of control of cost becomes the value of the total work or the sub-head of the work rather than the elements composing of the total work viz. material, labour and overheads. This being so, there is possibility of ignoring the increase and decrease of cost which might compensate each other in-as-much-as no opportunity is taken of for analysing the components of the total cost of the unit of work. It become, therefore, necessary to examine more closely the preparation of schedules of estimated costs under the three heads of material, labour and over-heads in order to show how dependent such a compilation of data is upon the progress of construction work.

Treatment of Overheads in Government Accounts

Another feature is Government accounts is that the overheads which constitute the cost of establishment of the management, Divisional Engineers-in-charge of the works and their subordinate staff are practically kept out of works accounts and the proportinate cost thereof is not indentified periodically with the cost of the works undertaken. The result is that the true cost of the work completed or work-in-progress is not assessed in a proper manner. On the other hand, most often the expenditure of establishment would be incurred as and when the time passes while the work during that period might not have progressed as per schedule. Even though the slackness in progress is taken cognizance of by the authorities, that actual cost of overheads on account of the slackness is not given true importance as is done in the case of standard costing under the head "Idle capacity." The Cost Accountant, maintaining standard costs in such cases will classify such expenditure in glaring terms and indicate against the idle capacity the various reasons attributable for the idle time. By doing so, the attraction of the authorities is at once drawn as the loss indicated in terms of rupees, annas and pies would reflect infructuous expenditure apportionable to that period. The effect thereof would be that they would take immediate action to stop or reduce such expenditure to the minimum and arrange for remedial measures, with a view to show better progress as per schedule in the ensuing period. Similar remarks would apply towards plant and machinery employed for the works.

Preparation of Estimates

In this context, a few words will not be out of place

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regarding the preparation and the details of the estimate. As the estimate should represent the true magnitude as closely as it can be determined by the exercise of sound judgment based on approximate computations, it should be not confused with off-hand approximations. It should be made up of three elements : labour, material and overheads. As far as possible it must represent the cost summary. It is usual to give the break-ups according either to the natural major divisions of work or by trades or both. In any case, full particulars of materials and and labour required and the amount thereof should be indicated tgether with the overhead cost allocable thereto, so that the variances to be derived while the cost is being computed on the standard cost method will be easily calculated.

Systematic Cost Accounting

True cost accounting should pay more attention to the computation of the variances under the three elements of cost, as its main object should be to find out the deviations from the original estimate and under which elements the deviations have occurred in terms of money value. If the estimate is sanctioned after due scrutiny thereof, the competent authority which has accorded sanction should also know the exact reasons for the variances and the stages at which they have occurred. Here the analysis of the Cost Accountant in terms of variances catches the real significance of the post of Cost Accountant.

Integrated Accounts

Let us now, therefore, see what the true 'integrated' accounting organisation as applicable to works and projects should be and how it may come to the assistance of the management in such matters. The main objects of cost accounting are :

(1) cost control, i.e. identifying with persons responsible for incurring and controlling it ;

(2) cost finding, i.e. identification of expenditure with divisions of works of sub-heads of works or services, as the case may be ;

(3) presentation of information to the management for the control and administration of the business concerned ;

(4) integration between cost and financial accounts ; (This is not applicable if integrated system is adopted as explained in this article) ; and

(5) to provide information for future estimates.

The branch of cost accounting has evolved itself to accounting by means of variances as most useful to to the management. The Engineer-in-charge of the project, to whom his original estimate or budget is the barometer for judging efficiency will be glad to understand the quantity of work done up to a particular date and the variances in cost upto that date. The monthly analysis of cost in terms of material, labour and overheads obtained by adopting "standard cost" method and indicating the variances from the budget in terms of money value, will furnish him all the particulars required by him including idle time, idle machinery and increase of overhead cost on that account, which would at once force him to rectify the defects to stop recurrence.

The above paragraphs would show that a scientific method is evolved in the field of cost accounting to furnish accounts in a suitable effective form by means of the "integrated method of accounting". The accountant (cost cum financial) will be able to submit, by means of this method, the financial figures together with variances under various heads which are required for control purposes by the management. As no two branches viz. cost and financial are employed, there is sure to be economy in the cost of maintenance of accounts department, and the vouchers as and when accounted for will be suitably classified so as to suit financial and cost requirement. Timely i.e. monthly submission of the variances by the Accountant to the Head of the Department (Accountant General in Government Departments) and then to the other authorities wherever necessary instead of through the medium of appropriation audit in the Audit Report several years after the work is completed and the expenditure is incurred, will prove most useful to all around from the cost control point of view, as the main object of the cost accountant of the modern days is to guide for the check of expenditure than only to write the historical costs after the completion of the work.

Adoption of the system of accounting described above would facilitate submission of a monthly report on variances in money value in the following form :

Total of variances during the month .... Rs. ..... analysis of which is an under :—

	Rs. As. Ps	Dept. responsible
Material : Due to price		
,, Design changes		
,, wrong budgetting		
,, quantity of material		
,, quality of material		
Labour : Due to Rate		
,, Time		
,, Design changes		
,, Labour efficiency		
,, wrong budgetting		
Overheads: Due to wrong budgetting		
,, Idle capacity (volume)		
,, Efficiency		

The Seminar Method

We do not know how the Engineers' Seminar idea was born and how it took shape. But it has proved to be a brilliant and useful one. Two Seminars have been held so far, at Nangal and at Roorkee, and both were pre-eminently successful. It is necessary to grasp fully the significance of the Seminar idea if we wish to take full advantage of this outstanding method.

Only a few years back the canal department of the P.W.D. was jocularly nicknamed by the engineers as the mud-department of the Government. But soon after Independence a very large number of river valley projects were taken up for execution. Today the entire country is veritably scattered with sites of intense construction activities of all varieties. Most of these are being executed by the State P.W.D., Irrigation and Power branches, and in some cases special organisations have been set up like the DVC, Bhakra-Nangal, Hirakud, etc. A semblance of coordination was taking place more in the realm of planning, investigating, designing, financing and purchasing, through the instrumentality of the Central Government. Soon enough it was being realised that what was more vitally necessary was a centre for intellectual exchange and pooling of rich experiences that our engineers have been making in the last few years. While each project has its own peculiarity or distinctive character, the method of execution in each sector of the project may be similar to that obtained in other projects. It is in the nature of a scientific approach and outlook that such men making their own experiences would like to compare their notes and sift out and classify the various factors involved in each process and try to evolve generalised principles, and thus feel enriched and intellectually strengthened. So long as the country seemed to stagnate in a mere mechanical repetition of canal digging in a visionless manner, no such urge was felt. But so soon as a new, fresh and invigorating experience was gone through, the urge to meet and discuss became increasingly irresistible.

The ushering of the Five-Year Plan stimulated the need in the fact that it was no longer possible to work in an isolated manner in different states and that, with increasing stress on national coordination, concrete problems began to emerge for urgent solution and policy-decision.

It is in this general background that the Seminar was first held. There was initially no idea of setting up a standing body to follow up its discussions. But the discussion soon pressed for such an organisation and a "Committee of Coordination of Engineers" was set up, together with a "Committee of Ministers" as a higher organ to finalise policy formulations on specific issues discussed.

Apart from the immediate utilitarian aspect that the Seminar served in helping the Ministers to arrive at uniform decisions, however, it is necessary to keep in mind that the Seminar fulfilled the more intangible and yet more basic need of the engineers busy at their job.

Some of the subjects discussed at the two Seminars, each of not more than 3 days duration, indicates the sweeping range of problems dealt with at great speed and efficiency. The subjects were :

At Nangal

1. Proper use of stores and machinery : their operation, maintenance and depreciation.
2. Assessment of technical manpower.
3. Estimates and costs.
4. Eradication of corruption.
5. Progress reports.

At Roorkee

A. Finalisation of subjects already discussed :

1. Report of the Plant & Machinery Committee.

B. Subjects for full discussion :

2. Unit Rates of Concrete and Masonry
   (*a*) Report of Nangal Seminar's Sub-Committee, and
   (*b*) Interim observations of the Rates & Costs Committee.
3. Standardisation of Progress Reports of Projects.
4. Preparation of Project Reports and Estimates, and Report of Nangal Seminar Sub-Committee on Estimates and Cost Trends.
5. Detailed Instructions for Investigations of Projects.
6. Assessment of Technical Manpower for long-term Planning and Training Facilities.
7. Organization and Administration of River Valley Projects.
8. Eradication of Corruption.

C. Introduction of new subjects not intended for discussion :

9. Soil Conservation on River Valley Projects.
10. Rural Electrification.
11. Relative Place of Masonry and Concrete in Dams.
12. Gradual Reduction and Replacement of Foreign Experts.

At the next Seminar to be held shortly, the following subjects will be discussed :

1. Report on Organization and Administration of River Valley Projects.
2. Report of the Rates & Costs Committee.
3. Interim Report of Technical Manpower Committee.
4. Detailed Instructions for Investigations of Projects.
5. Standardisation of Progress Reports & Charts.
6. Preparation of Project Reports and Estimates.
7. Measures to accelerate Utilisation of Water.
8. Measures to accelerate Utilisation of Power.
9. Steps to be taken to ensure achievement of Construction Schedules.

Is there any doubt that these questions are of vital importance to the country? That such regular discussions are taking place among high level experts on an all-India basis before the Ministers of States and the Centre are finally making up their minds is an important landmark in the realm of engineering administration in India. We have thus reached a stage which qualitatively is much richer and sounder in this matter than the situation which had existed a few years back.

After this general appreciation of the contribution that the Engineers Seminar has made, it is necessary to consider in what ways is it possible to improve upon this institution and method so that it serves its purpose more effectively.

To us it at once strikes that the intellectual participation in the matter of general discussion of different issues at the Seminar is limited to a few.

The newer experience are being made not only by the Chief Engineers but also by other engineers. Possibly those others are much more face to face with many problems than the engineers at the topmost rung of the ladder. Would it not be better to so conduct the Seminar that the discussion of the different issues is made open to a large number of other engineers? This does not necessarily mean that the attendance at the Seminar is to be doubled or trebled. Rather, the idea is that each item to be discussed be introduced in the manner as Mr. Vadera did at Roorkee, well in advance, in the form of a note and circulated to, say, the branches of the Institution of Engineers, State P.W.D.'s, Project Authority Centres, Engineering Colleges and other allied institutions. Let these be discussed in groups and notes prepared of such discussion. Only when such a process has been gone through and a gist made available to the Chief Engineers, should the Seminar meet and discuss the issues.

Such a procedure will serve three purposes. Firstly such discussions on important problems, promoted on an all-India basis, will help the general intellectual movement in the country, particularly among the engineers. Secondly, those who are actually on the fields of operation but may not be of the rank of a Chief Engineer would get an opportunity of saying something, and some of these may be found really worthwhile. Thus we shall promote a process by which newer and younger talents could be spotted out and encouraged—a much-needed step. Thirdly, the Chief Engineers and others attending the Seminar would have before them not only their own ideas and experiences to help them but also those of others emerging out of the preceding general discussion in the country.

In this context we would like to point out that it is not proper to value the Seminar only "in terms of rupees, annas and pies" as Sri G. L. Nanda remarked at Roorkee. It is much more than that. It is primarily serving as a mechanism to promote intellectual fermentation among engineers to consider innumerable problems arising out of their creative experience gained in construction work. The utilitarian aspect, however, need not thereby be minimised at all. It is also not intended that the conduct of the Seminar meetings be unbusinesslike.

On the other hand it is also true that if the Seminar idea is broad based, as suggested above, and not conducted more or less in a departmental way, its secretariat will have to be strengthened and persevering encouragement to groups of engineers scattered over the country to promote discussion will have to be made. That, no doubt, means more time and greater alertness in picking up brighter ideas. But that will amply repay in the long run.

It is possible that the Seminar idea was not concieved in this light initially. Even so, if this approach now appears to be sounder, we would commend it for adoption. Of course, it is sounder to mention that if a Journal like ours could be of any little assistance in the matter, we shall feel privileged to be so.

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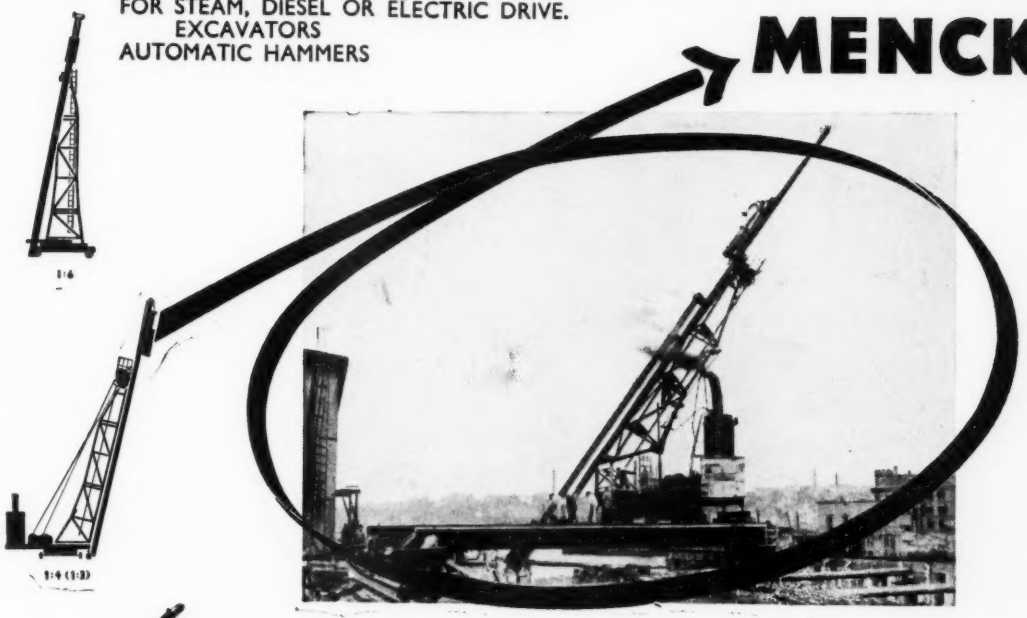

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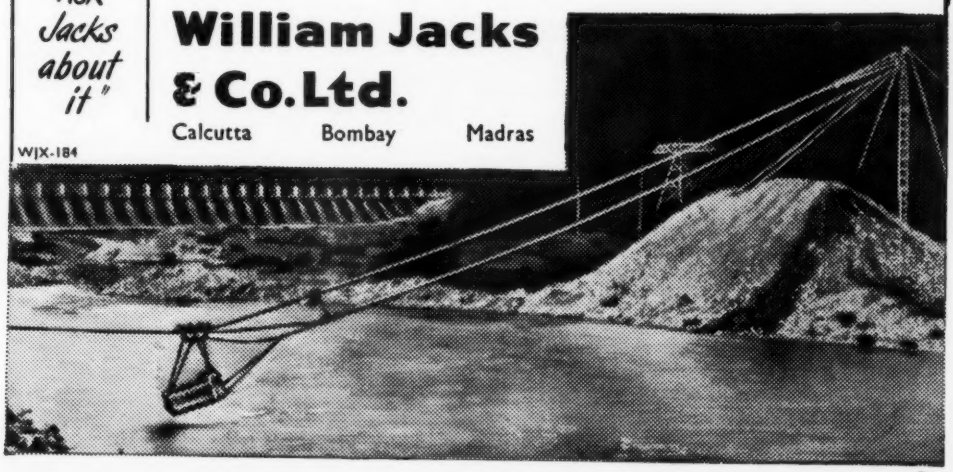

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